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REVISION OF THE AUSTRALIAN GENUS *ANOMALOMORPHA* ARROW (COLEOPTERA: SCARABAEIDAE: DYNASTINAE) WITH A NEW SPECIES FROM THE WET TROPICS OF QUEENSLAND

P.G. ALLSOPP

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Three species of the Australian dynastine genus *Anomalomorpha* Arrow are recognised: two described previously, *A. anthracina* Arrow and *A. giveni* Carne, and a new species from wet sclerophyll forest in northeastern Queensland, *A. monteithi* sp. n. The status of *A. flavipes* Arrow and *A. geotrupina* Arrow as junior synonyms of *A. anthracina* is confirmed. Lectotypes are designated for *A. anthracina* and *A. flavipes*. ❒ *Coleoptera, Scarabaeidae, Dynastinae, Anomalomorpha, taxonomy.*

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Arrow (1908) erected *Anomalomorpha* for three species from eastern Australia that he then described: *A. anthracina, A. geotrupina* and *A. flavipes*. In his landmark revision of the Australian Dynastinae, Carne (1957) synonymised *geotrupina* and *flavipes* under *anthracina* and designated the last as the type species of the genus. He noted slight variation between the types in the emargination and relative dimensions of the pronotum and in both the pronotal and pygidial punctation. However, he could find no differences in male genitalia and considered that the type of *geotrupina* was an imperfect specimen in which the punctuation of the clypeus is partially obliterated. He also described a further species, *A. giveni*, which he only hesitatingly included in *Anomalomorpha;* he recharacterised the genus to allow this inclusion. Endrödi (1974, 1985) and Cassis & Weir (1992) followed this arrangement. Endrödi also provided a key to distinguish the two species. As then recognised, *A. anthracina* was known from the Atherton Tableland south to central-western Victoria and inland to Cunnamulla, whilst *A. giveni* was known from central-eastern New South Wales to central-western and southern Victoria (Carne, 1957).

Recent collecting by the Queensland Museum at several sites in very high altitude wet sclerophyll forest along the western edge of the rainforest plateaus in the Wet Tropics of northeastern Queensland has discovered a third species. This necessitates a reappraisal of the genus.

Collection abbreviations used are: AM, Australian Museum, Sydney; ANIC, Australian National Insect Collection, Canberra; BSES, Bureau of Sugar Experiment Stations, Bundaberg; MV, Museum of Victoria, Melbourne; NHM, Natural History Museum, London; NSWA, New South Wales Agriculture, Orange; PGA, Peter Allsopp collection; QDPI, Queensland Department of Primary Industries, Indooroopilly; QPIM, Queensland Department of Primary Industries, Mareeba; QM, Queensland Museum, Brisbane; SAM, South Australian Museum, Adelaide; UQIC, University of Queensland Insect Collection, St Lucia; VAIC, Victorian Agricultural Insect Collection, Agriculture Victoria, Melbourne. Depositories are only cited when different from the previous citation. Abbreviations for collectors: EA, E. Adams; EB, E. Britton; PC, P.B. Carne; DC, D. Cook; GM, G. Monteith; ES, E. Sutton,

Anomalomorpha Arrow, 1908

TYPE SPECIES. *Anomalomorpha anthracina* Arrow, 1908, subsequent designation by Carne (1957).

DESCRIPTION. Body low convex, unarmed, somewhat ruteline in appearance. Dark reddish-brown to almost black, sometimes sericeous, legs elongate, reddish or yellowish-brown. Clypeus rounded, or almost rectangular; moderately emarginate. Ocular canthi setose. Mentum flat; ligula broadly rounded, weakly bilobed. Maxilla with small, untoothed galeae. Mandibles simple, rounded, obscured together with labrum by clypeus. Maxillary palps slender, elongate. Antennae 9- or 10-segmented, club 3-segmented, club shorter than shaft, segments 1-2 of shaft setose. Pronotum widest in basal half, anterior ridge often with weak median node, surface finely punctate. Elytra with sutural striae linear-punctate, disc with punctures small but moderately impressed, random punctures rare on intervals; epipleurae well developed, with conspicuous lateral setae present posteriorly at least as far as propygidium. Pygidium glabrous, excepting a few long setae at sides in anterior third, or with sparse setae in line across anterior third. Postcoxal process of prosternum slender, tapering, sloping posteriorly, abundantly setose. Fore tibiae 3-dentate; tarsi elongate, much longer in males than in females; claws simple, robust, larger in males than in females. Hind legs slender, tibiae with carinae obscure, distal ciliae sharp and slender, smaller spur curved, spurs longer and more slender in males than in females. Male genitalia with gonostyli untoothed on inner margins, setose on apical margins in some species.

REMARKS. *Anomalomorpha* occupies a relatively isolated position within the Australian Cheiroplatina, having the galeae of the maxillae reduced to small conical pieces terminated by pencils of sensory hairs and by lacking armature on the pronotum or clypeofrontal ridge. *Anomalomorpha* is distinguished from *Adoryphorus* by the elongate fore tarsi, the large, robust claws, and the slender, conspicuous maxillary palps.

Anomalomorpha anthracina and *A. monteithi* sp. nov. are very closely related and undoubtedly congeneric. Like Carne (1957), I find the inclusion of *giveni* in *Anomalomorpha* more problematical. It differs most markedly in the coloring of the body and legs, in having 9- rather than 10-segmented antennae, and in having glabrous apices of the parameres. However, the three species do share many other characters and the allopatric, but adjacent, distributions of *giveni* and *anthracina* (Fig. 1A) suggest that the two species have similar biologies and compete for near identical niches. I follow Carne and retain *giveni* in *Anomalomorpha*.

KEY TO SPECIES OF *ANOMALOMORPHA*

1 Body and legs brown to reddish brown; antennae 9-segmented; pygidium glabrous on disc; parameres (Fig. 2A-B); highlands of SE NSW and Vic (Fig. 1A) . . . . *giveni* Carne

Body reddish brown to black, legs yellowish in preserved specimens, almost white when alive; antennae 10-segmented; pygidium with at least a few long setae in a transverse line at about one-third of length. 2

2 Dorsal surface shining; distance between outer edges of canthi 1.8-1.9 times interocular distance; pygidium with few long setae at sides in anterior third; parameres (Fig. 2C-D); body 11.5-17mm long; eastern Australia from NE Qld to inland Vic (Fig. 1A) . . . *anthracina* Arrow

Dorsal surface sericeous; distance between outer edges of canthi 1.6-1.65 interocular distance; pygidium with line of very long setae across anterior third; parameres (Fig. 2E-F); body 19.2-20.8mm long; wet sclerophyll forest to the west of tropical rainforest in NE Qld (Fig. 1A-B) . . . . *monteithi* sp. nov.

Anomalomorpha giveni Carne
(Figs 1A, 2A-B)

Anomalomorpha giveni Carne, 1957: 115.

MATERIAL. PARATYPES. Specimens in ANIC, SAM, MV and QDPI. NEW MATERIAL (All ANIC). Australian Capital Territory: 1♂, Black Mountain, 30.xi.1951, L. Chinnick; 7♂, 5♀, Braddon Bowling Green, 4.xi.1965; 1♂, Deakin, 17.xi.1964, EB; 1♂, Yarralumla, 11.iv.1929, G.F. Hill, under turf; 1♂, Yarralumla, 21.iii.1957, PC; 3♂, Yarralumla, 13.xi.1971, R. Kohout. Victoria: 1♂, 3 mi E Lake Bolac, 17.iv.1951, PC.

DESCRIPTION. Body 12-14mm long; reddish brown. Clypeus transverse, moderately emarginate, males with sides subparallel near base and then curving evenly to more or less straight anterior margin, truncated face subvertical and with scattered, short setae across disc, females evenly rounded, anterior truncated face oblique with scattered, very short setae across disc; upper surface glabrous. Head glabrous, lightly but abundantly rugulose-punctate; clypeofrontal ridge transverse, slightly effaced in middle third; distance between outer edges of canthi 1.4-1.45 times interocular distance. Maxillary palps elongate in males with segment 2 and 4 about equal in length, in females less elongate with segment 2 much shorter than segment 4, segment 4 3.8 times as long as greatest width, slightly curved, sensilla hardly indented, apex rounded. Antennae 9-segmented, club shorter than segments 2-7 combined. Pronotum weakly convex, widest at basolateral angles, anterolateral angles slightly acute and continuing to almost straight anterior margin, anterior margin marked by a weak ridge laterally but flat and without ridge medially, basal ridge absent, disc with surface shining, sparsely micropunctate, with faint median stripe becoming more distinct posteriorly; lateral margins without defined grooves. Scutellum impunctate. Elytra with sutural striae linear-punctate, disc microreticulate, striae with small annulate punctures, intervals almost impunctate; lateral margins with fine ridge defining emargination; epipleurae vertical, broad at base, with conspicuous lateral setae extending as far as pygidium. Fore tibiae broad, basal tooth small; males with segment 5 of tarsi elongate, almost 2 times length of segment 1, females with tarsi shorter; males with claws very large, about as

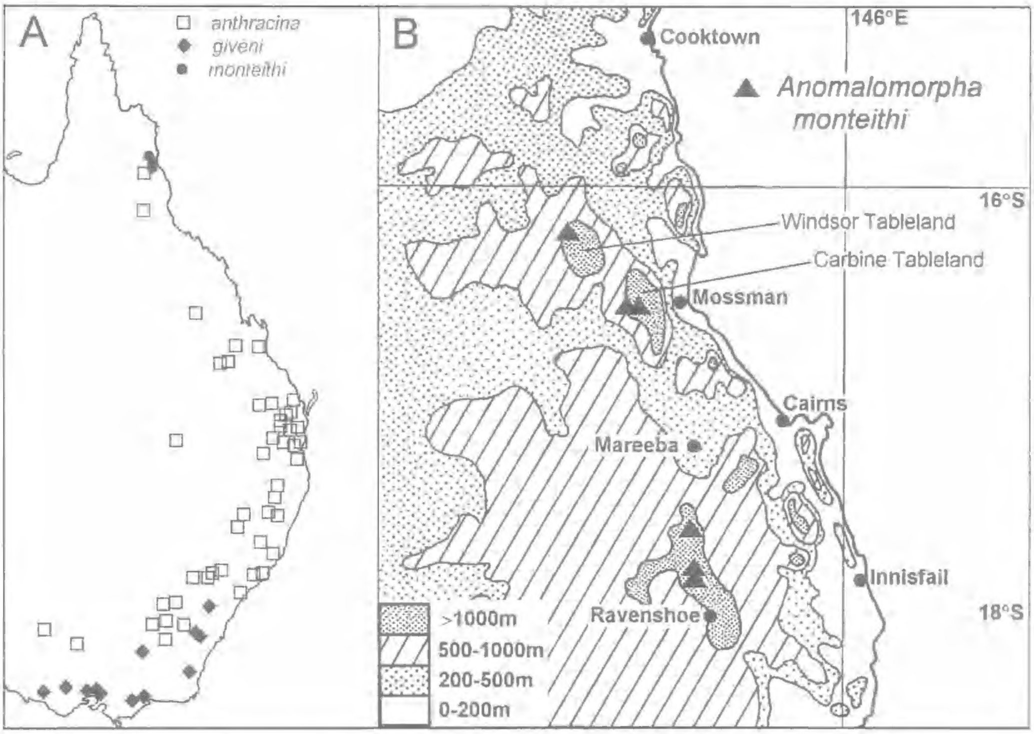

FIG. 1. Distribution of *Anomalomorpha* spp; A, eastern Australia showing distributions of all three species; B, northeastern Queensland showing distribution of *Anomalomorpha monteithi* relative to the mountain massifs of the wet tropics region.

long as tarsal segment 5, females with claws shorter than tarsal segment 5. Hind legs slender, tibiae obscurely 3-carinate, distal ciliae long, sharp, closely set; spurs unequal, both curved, slender in males, shorter and broader in females. Pygidium moderately convex in males, almost flat in females; shining, glabrous, finely punctate across base, disc sparsely micropunctate, microreticulate; apical ridge broadened, not divided, setose on either side of middle. Ventral thorax with long, pale-yellow setae. Abdominal sternites with line of long setae across middle of each segment. Parameres symmetrical, glabrous (Fig. 2A-B).

REMARKS. *A. giveni* replaces *A. anthracina* in the highlands of southeastern Australia and in southern Victoria (Fig. 1A). Collection records indicate main adult activity in October-November and again in March-May; this suggests a short larval period during summer followed by a long adult period through autumn, winter and spring, similar to some other dynastines (Allsopp & Logan, 1999).

Anomalomorpha anthracina Arrow
(Figs 1A, 2C-D)

Anomalomorpha anthracina Arrow, 1908: 345.
Anomalomorpha flavipes Arrow, 1908: 346; Carne, 1957: 114 (syn.).
Anomalomorpha geotrupina Arrow, 1908: 345; Carne, 1957: 114 (syn.).

MATERIAL. TYPES. *A. anthracina*: Lectotype ♂ (here designated), bearing the labels 'Lectotype' (circular, blue-bordered), 'Type' (circular, pink-bordered), '5306', '♂', 'Moreton Bay', 'T5 36', 'Anomalomorpha anthracina Arrow type ♂', my lectotype label, mouthparts and aedeagus dissected out and mounted on cards (NHM); paralectotypes 1♂, 1♀, Austral[ia] (NHM). *A. geotrupina*: Holotype ♂, Qld (NHM). *A. flavipes*: Lectotype ♂ (here designated), bearing the labels 'Lectotype' (circular, blue-bordered), 'Type' (circular, pink-bordered), 'Rockhampton' (oval, green), 'Dasygnathus couloni Burm.', '♂', 'Pascoe Coll. 93-60', 'Anomalomorpha flavipes Arrow type', my lectotype label, aedeagus dissected out and mounted on card (NHM); paralectotypes: 1♂, Mackenzie R[iver] (NHM); 1♂ Qld (SAM); 2♂, Brisbane, A.J.Turner (SAM). OTHER MATERIAL. Queensland: 1♂, Ravenshoe, i.1929 (AM); 1♀, 2 ml N of Greenvale H.S., [115km] W of Ingham, 5.iv.1962, K.H.L. Key & E.L.

Crby (ANIC). 3♂, 1♀, Clermont, 11.xii.1929, 13.xii.1929, K.K. Spence (AM); 1♂, Rockhampton; 1♂, 4♀, Mourangee, Edungalba, 1.xii.1968, 6.xii.1968, EA, at light; 2♂, 1♀, 'Separation', Edungalba, 6.xi.1970, EA; 1♂, 1♀, 25°26'S 150°01'E, Taroom district, adjac. Boggomoss No. 3, 11.xi.1996-i.1997, P. Lawless, pitfall (QM); 1♀, 25°26'S 150°01'E, Boggom[oss] 3 via Taroom, 12.xi.1996-i.1997, DC&GM, pitfall trap; 1♂, 25°36'S 149°46'E, 6km N Taroom, 11.iv.1993, G & A. Daniels (UQIC); 1♂, 25°36'S 149°46'E, Taroom district, 7km N Ooline Scrub, 12.xi.1996-i.1997, P. Lawless, roadside B234, pitfall 127 (QM); 8♂, Childers, 4.i.1926, 13.xii.1926, 18.xii.1926, R.W. Mungomery, at light (AM, BSES, SAM); 1♂, Wondai, 13.xi.1930 (UQIC); 2♂, Booie, 16.xii.1978, J. Wessels (QDPI); 1♂, Kingaroy, 14.xi.1976, H. Brier; 1♂, Kingaroy, 1.xii.1976, J. Wessels; 7♂, 1♀, Yarraman, xii.1935, A.R. Brimblecombe; 1♂, Toogoolawah, i.1922, R.L. Higgins (QM); 1♂, Bunya Mountains, 14.xii.1937, N. Geary (AM); 1♂, 2♀, Koehler Rest Area via Kaimkillenbun, 28.xii.1978, K.J. & T.A. Lambkin, at light (QPIM); 3♂, 2♀, Dalby, F.H. Hobler (QM, SAM); 1♂, Toowoomba (AM); 1♂, Toowoomba, xii.[19]38, H.J. (UQIC); 1♂, 4♀, Toowoomba, 22.x.1972, 10.xii.1973, 2.i.1974, 24.xii.1974, P. Allsopp (PGA); 7♂, 4♀, Toowoomba, 21.xii.1973, 27.xii.1973, J. Macqueen (ANIC); 1♂, Toowoomba, 22.xii.1982, R.H. Broadley (QDPI); 1♂, Toowoomba, 1.xi.1936 (UQIC); 1♂, Gatton, 19.xii.[19]20 (QPIM); 1♂, Lawes, 5.iv.1952, T. Denmead (UQIC); 1♂, Samford, 12.xii.1970, GM; 1♂, Ferny Grove, 26.i.1944 (ANIC); 1♀, Brisbane, A.J. Turner (SAM); 3♂, 2♀, Brisbane, 17.i.1912, 21.i.1919, H. Hacker (QM, SAM); 1♂, Brisbane, O.W. Tiegs (QM); 1♀, Toowong, 3.v.[19]06 (MV); 1♂, Redland Bay, xii.1933, A.R.B. (QDPI); 2♂, Cunnamulla, x.1944, N. Geary (AM); 1♂, Inglewood, S. Tullus (AM); 1♂, [Lamington] National Park, xii.1923, H. Hacker (QM); 1♂, Macpherson Ra., 1923, H.T. (QDPI); 1♀, Stanthorpe, 18.iii.1924, ES (QM); 2♂, 2♀, Stanthorpe, 6.i.1926 (QDPI, UQIC); 1♂, Stanthorpe, 19.xii.1927 (UQIC); 2♂, Stanthorpe, 19.xii.1930; 1♂, Stanthorpe, Gemmell (ANIC); 2♂, 2♀, Stanthorpe, ES (QM); 1♂, Fletcher, ES; 1♂ (MV). New South Wales: 2♂, Tenterfield (ANIC, MV); 1♂, Graman, 8.i.1969, T.V. Bourke (NSWA); 1♂, Glen Innes, 27.i.1939, K. Green (ANIC); 2♂, Bingara, 8.i.1977, 10.i.1978, S. Runko (ANIC); 1♀, Armidale, 4.i.1961, C.E. Chadwick (NSWA); 9♂, 2♀, Armidale, 7.ii.1980, G.J. Goodyer, crawling over pasture; 1♂, Armidale, 14.ii.1980, C.R. Haywood, light trap; 1♂, Ebor, C.F. Deuquet (MV); 1♀, Laurieton, 18.iii.1981, J. Read (NSWA); 2♂, 3♀, Wheogo, near Dunedoo, xii.1928, 23.xii.1928, 27.xii.1928, A. Musgrave (AM); 1♂, Wellington, 2.xi.1891 (SAM); 1♂, Mudgee (AM); 1♂, Bindogundra, W. Harris (SAM); 1♂, Maitland, 1892, Froggatt (ANIC); 1♂, Pokolbin, 25.i.1955, I.G. Filmer (QM); 1♂, Sydney (AM); 1♀, Grenfell (ANIC); 1♂, Wedden Forest [Weddin Mountains NP], xii.1900, Cox (ANIC); 1♂, 1♀, Young, 5.iii.1927, TG; 1♀, Coolac, 21.i.1037, R.S. (SAM); 1♂, Tangman, Junee, 23.ii.1951, PC (ANIC); 1♀, Ladysmith, xii.1959, R. Smith; 1♀, Batlow, xii.1911 (NSWA); 1♀ (MV). Victoria: 1♀, Cowangie, i.1933 (NSWA); 2♂, 1♀, Korong Vale (VAIC); 3♂, 1♀, Korong Vale, G.W. Davey (MV). Western Australia: 1♂, 1♀ (MV). Australia: 5♂, 4♀ (AM, ANIC, NSWA, QDPI, QM, SAM, UQIC).

DESCRIPTION. Body 11.5-17mm long; reddish black to black (tenerals brown), legs in preserved specimens yellowish to reddish brown, almost white in live specimens. Clypeus almost rectangular, lateral margins a little more diverging in females than males, emarginate anteriorly; truncated face with few setae in angles and scattered, often abraded, setae across disc; upper surface glabrous. Head glabrous, strongly and evenly punctate anterior and just posterior to clypeofrontal ridge, frons posteriorly almost smooth; clypeofrontal ridge posteriorly angulate, giving rise to an obtuse interocular elevation or tubercle; distance between outer edges of canthi 1.8-1.9 times interocular distance. Maxillary palps with segments 1 and 3 about equal in length, segment 2 longer but shorter than segment 4, segment 4 3.5 times as long as greatest width, sensorium shallow and elongate on basal half, apex rounded. Antennae 10-segmented, club shorter than segments 2-7 combined. Pronotum widest in basal half, anterolateral angles slightly obtuse and continuing into a curved anterior margin, anterior margin marked by a ridge which often has a slight median node, basal ridge absent, disc with sparse fine punctures, weak impunctate stripe and slight depression in midline near base; lateral margins with broad emargination. Scutellum rugose on disc. Elytra with sutural striae linear-punctate, disc microreticulate, striae with small annulate punctures, intervals almost impunctate; lateral margins emarginate; epipleurae almost horizontal in anterior half, with conspicuous lateral setae as far posteriorly as propygidium. Fore tibiae with basal tooth much smaller than middle tooth; tarsi with segment 5 longer than segment 1, tarsi much longer than tibiae in males, about equal in females. Hind tibiae 2- or 3-carinate, ciliae long, sharp, closely set, inner spur about half length of outer in males, more than half length in females. Pygidium highly convex in males, slightly convex in females; with few long setae at sides in anterior third (often lost by abrasion), finely punctate at sides, disc microreticulate, apical ridge setose, narrow. Ventral thorax with long, thin setae. Abdominal sternites with line of setae across middle in posterior third. Parameres symmetrical, setose towards apices (Fig. 2C-D).

REMARKS. Designation of lectotypes for *anthracina* and *flavipes* is necessary because Arrow saw two males and one female of *anthracina* and five males of *flavipes*. Although he always designated at least one specimen of each new species as a 'type' (Bacchus, 1978), this is not an acceptable designation of a holotype. One specimen of each bears a lectotype label placed there by Mark Russell in 1973 (M. Kerley, pers. comm.). This was probably a precursor to publication of the designations, as in Bacchus (1974, 1978); but this was not done. I have designated the same specimens as lectotypes. *Anomalomorpha geotrupina* was based on one specimen ('I have seen only a single (male) specimen'), so the status of the type is unambiguous.

Anomalomorpha anthracina is known from most of mainland eastern Australia, excepting Cape York Peninsula, the highlands of southern New South Wales and the southern half of Victoria (Fig. 1A). In the absence of other species from that state, I regard the label data on specimens from Western Australia as highly dubious; as they were in the French collection, they were collected early this century or during the late 1800s. Other eastern Australian specimens in the French Collection are known to have been wrongly labelled from Western Australia (G.B. Monteith, pers. comm.). The record of Ravenshoe, Queensland, requires confirmation; the male is an old specimen and no recent specimens are known from that area, despite recent intensive collections. Carne (1957) did see a specimen from nearby Herberton, but I have not located it. The possibility remains that past records from Ravenshoe and Herberton may have been based on specimens of the new species from that region described in this paper as *A. monteithi*.

Collection data indicate that adults are active in October-December in Queensland and later, December-March, through New South Wales. The collection data of April for the Ingham specimen appears anomalous.

Anomalomorpha monteithi sp. nov.
(Figs 1A-B, 2E-F, 3)

ETYMOLOGY. For Geoff Monteith who collected and recognised the novelty of this species.

MATERIAL. HOLOTYPE: QMT62780, ♂, 16°27'S 145°11'E, Mt Spurgeon, 19.xi.1997-8.ii.1998, Monteith & Cook, O/F [open forest] trap 1, pitfall trap, 1100m. PARATYPES (8): 2♂, same data as holotype; 1♂, 16°28'S 145°12'E, Mt Spurgeon, 19.xi.1997-8.ii.1998, GM&DC, O/F [open forest] trap 6, pitfall trap, 1110m; 1♂, 16°28'S 145°12'E, Mt Spurgeon, 20.xi.1997-8.ii.1998, GM&DC, O/F [open forest] trap 7, pitfall trap, 1120m; 1♂, 16°13'S 144°59'E, Windsor Tblnd [Tableland], 8.ii.1998, DC, NW open forest, arrived daytime, dung trap, 1180m; 1♂, 17°20'S 145°25'E, Baldy Mtn Rd. 2km from S end, 30.xi.1997-5.ii.1998, GM&DC, open forest, pitfall, 1120m; 1♂, 17°27'S 145°27'E, Webster Road, Evelyn, 30.xi.1997-5.ii.1998, GM&DC, open forest, pitfall, 990m; 1♂, 17°28'S, 145°27'E, Byers Rd, Evelyn, 30.xi1997-5.ii.1998, GM&DC, open forest, pitfall, 1040m. Paratypes in ANIC, QPIM, QM.

DESCRIPTION. Body 19.7-20.8mm long; dorsal surface dull, sericeous, not shining, head, pronotum and scutellum reddish black to black, elytra reddish black on outer third to half, inner areas reddish brown, pygidium and ventral surface reddish black, legs in preserved specimens yellowish with tarsi reddish brown, almost white in live specimens. Clypeus almost rectangular but with anterior angles rounded, lateral margins similar in both sexes, emarginate anteriorly; truncated face with few setae across basal margin, otherwise almost smooth. Head strongly and evenly rugose anterior and just posterior to clypeofrontal ridge and on ocular canthi, frons posteriorly almost smooth; clypeofrontal ridge posteriorly sharply angulate, giving rise to a low interocular horn to tubercle in males or tubercle in females; distance between outer edges of canthi 1.6-1.65 times interocular distance. Maxillary palps with segments 1 and 3 about equal in length, segment 2 longer but shorter than segment 4, segment 4 3.7 times as long as greatest width, sensorium deep and elongate on basal half, continuing to apex as a narrow, deep trough, apex with 2 tuberculi. Antennae 10-segmented, club about as long as segments 2-7 combined. Pronotum widest in middle, anterolateral angles right-angled and continuing into a three-part anterior margin with the larger middle section straight and transverse, anterior margin marked by a ridge which often has a very slight median node, basal ridge absent, disc with sparse, very fine punctures and microreticulate between punctures, weak depressed area in midline near middle; lateral margins evenly curved and with narrow emargination. Scutellum rugose on disc. Elytra with striae with small annulate punctures, intervals almost impunctate; and microreticulate lateral margins emarginate; epipleurae almost horizontal in anterior half, with conspicuous lateral setae as far posteriorly as propygidium, short, denser setae on apical half. Fore tibiae with basal tooth much smaller than middle tooth; tarsi with segment 5 longer than segment 1, tarsi much longer than tibiae in males, about equal in females. Hind tibiae 2- or 3-carinate, ciliae long, sharp, closely

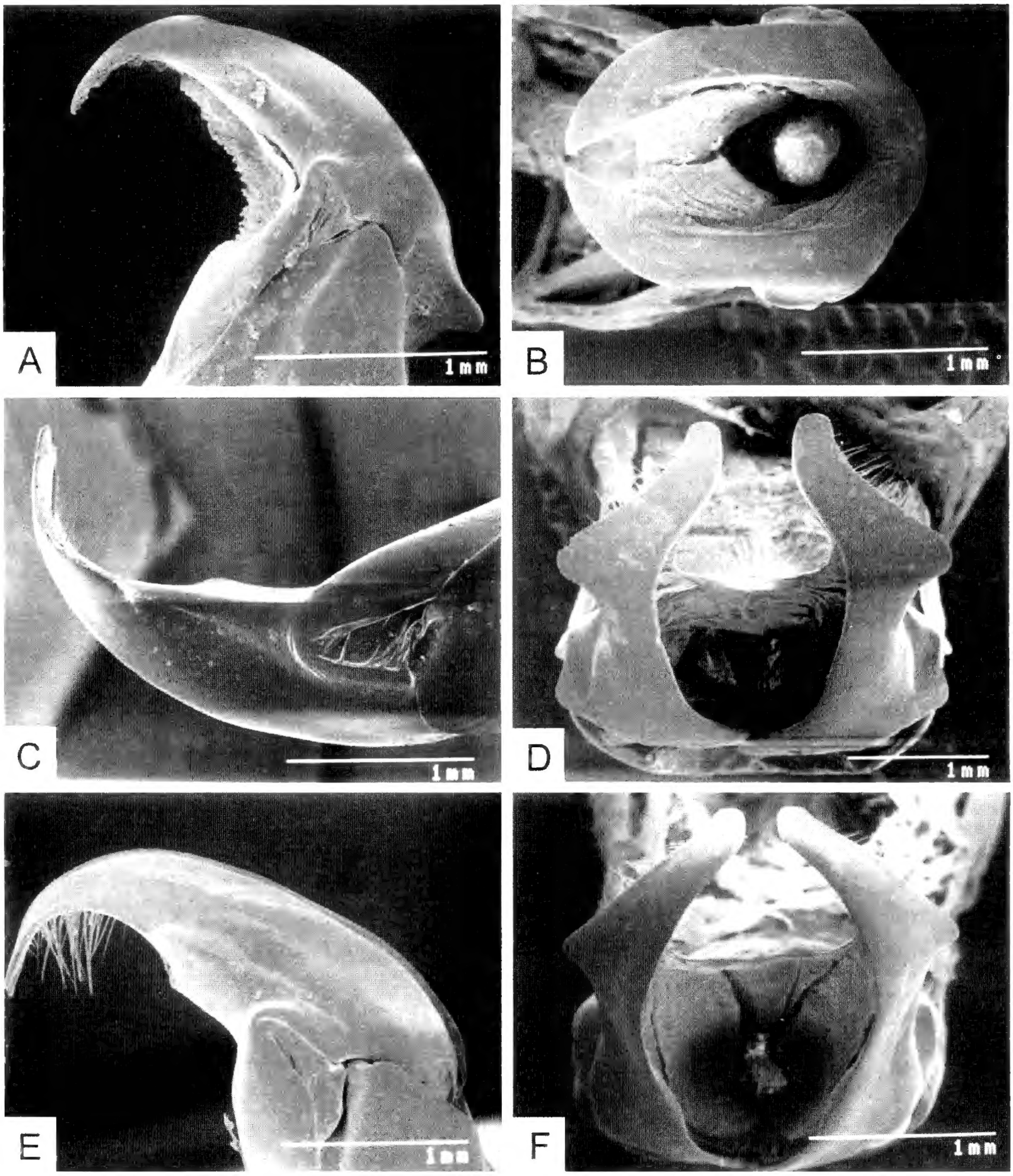

FIG. 2. Aedeagi of *Anomalomorpha* species. A-B, *A. giveni*; C-D, *A. anthracina*; E-F, *A. monteithi*.

set, inner spur about three-quarters length of outer in males, almost as long in females. Pygidium highly convex in males, slightly convex in females; with a line of very long setae across anterior third, finely punctate at sides, disc rugose-punctate, apical ridge setose, narrow. Ventral thorax with long, thin setae. Abdominal sternites with line of setae across middle in posterior third. Parameres symmetrical, distinctly toothed, setose towards apices (Fig. 2E-F).

REMARKS. *Anomalomorpha monteithi* is known from four sites in very high altitude wet sclerophyll forest along the western edges of

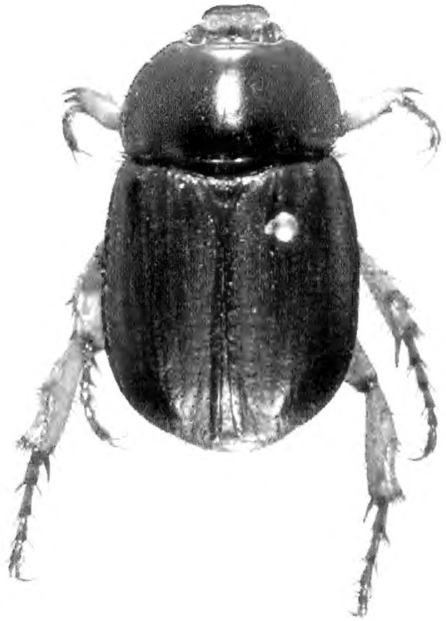

FIG. 3. Holotype ♂ *Anomalomorpha monteithi*. (Photo Jeff Wright, QM)

rainforest plateaus in the Wet Tropics area of northeastern Queensland (Fig. 1B). These forests, which are dominated by *Eucalyptus grandis* and *E. resinifera*, are very limited in extent (Tracey & Webb, 1975; Harrington et al, 2000) and are believed to be declining in area due to rainforest expansion under fire restricted regimes (Flannery, 1994; Harrington & Sanderson, 1994). Biogeographically *A. monteithi* is interesting, as it appears to be a temperate relict in high altitude open forest, paralleling the distribution of mammals such as the yellow-bellied glider (*Petaurus australis reginae*) and the northern bettong (*Bettongia penicillata tropica*), which are similarly restricted to this habitat in the wet tropics.

Beetles fly at least during the day; one was found in a pitfall trap set out earlier the same day (G.B. Monteith, pers. comm.). All were collected during the 1997-98 summer; none were taken in similar traps set out in the same areas in 1998-99 summer.

ACKNOWLEDGEMENTS

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SOME GENERA AND SPECIES OF GROUND BEETLES NEW TO AUSTRALIA (COLEOPTERA: CARABIDAE)

MARTIN BAEHR

Baehr, M. 2000 12 31: Some genera and species of ground beetles new to Australia (Coleoptera: Carabidae). *Memoirs of the Queensland Museum* **46**(1): 9-14. Brisbane. ISSN 0079-8835.

Four genera of ground beetles are newly recorded from Australia: *Euplynes* Schmidt-Goebel (Agoninae), with the new species *E. decoloratus* sp. nov.; *Lachnothorax* Motschulsky (Odacanthinae), with the species *L. tokkia* Gestro; *Mochtherus* Schmidt-Goebel (Lebiinae), with the species *Mochtherus obscurus* (Sloane); and *Oxyodontus* Chaudoir (Lebiinae), with the species *O. tripunctatus* Chaudoir. *Dicraspeda longiloba* (Liebke) (Odacanthinae) is also newly recorded for Australia. It may be an example of re-immigration of an old Australian stock into Australia. Previous Australian and New Guinean records of *Catascopus smaragdulus* Dejean refer to the recently described species, *Catascopus moorei* Straneo, of which further Australian material is noted. These new records further stress the important role of the Cape York Peninsula as a gateway for the immigration of Oriental and Papuan elements into Australia. As most of the newly recorded species are widespread outside Australia and have not differentiated morphologically in Australia, these are probably recent immigrations. ☐ *Coleoptera, Carabidae, Australia, Cape York Peninsula, distribution, new species.*

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During a visit to the Queensland Museum insect collection, Brisbane, I noted several carabid species from genera which are widespread in the Oriental Region, though not recorded for Australia. There were also New Guinea species not yet recorded from Australia. Since the Oriental-Australian faunistic relations are not yet fully understood, the new records are worth recording, even though most are well known genera and species relatively widespread in the Oriental and/or Papuan regions. These new records also demonstrate that the fauna of northern Australia, in particular that of Cape York Peninsula, is even more closely related to that of New Guinea and the Oriental Region than previously expected.

MATERIALS AND METHODS

Measurements were made with an ocular micrometer under a stereo microscope. Length was measured from apex of labrum to apex of elytra. Length of pronotum was taken along the midline. Measurements, therefore, may slightly differ from that of other authors, especially Darlington.

All material is in the Queensland Museum (QM), except for duplicates lodged in the Zoologische Staatssammlung, Munich (CBM) where indicated. Collectors are G. Monteith (GM), D. Cook (DC) and M. Baehr (MB).

Family CARABIDAE
Subfamily AGONINAE
Euplynes Schmidt-Goebel

Euplynes decoloratus sp. nov.
(Figs 1-3)

ETYMOLOGY. Referring to the the faded colour of the surface compared to the closely related, brightly coloured, *Euplynes apicalis* Darlington from New Guinea.

MATERIAL. Holotype. ♂, QMT93014, West Claudie R., Iron Range, N Qld, 3-10.xii.1985, G.B. Monteith & D. Cook, Pyrethrum knockdown/RF (QM). Paratypes: 21♂, 7♀, same data (QM, CBM); 2♂, 1♀, Iron Range, Cape York Pen. N Qld 5-10.v.1968, G. Monteith (QM); 1♂, Gordon's Mine Area, Iron Range, N Qld 12-18.ii.1976, G.B. Monteith, rainforest (QM).

DIAGNOSIS. Species of *Euplynes* with markedly impressed, but not differently coloured, posthumeral patch on elytra. Distinguished from the most closely related species, the New Guinean *E. apicalis* Darlington, by conspicuously faded, only indistinctly metallic blue surface of elytra and by absence of a distinct, reddish apical margin.

DESCRIPTION. *Measurements.* Length: 5.7-7.2mm; width: 2.55-3.4mm. Ratios: width pronotum/head: 1.30-1.35; width/length of pronotum: 1.44-1.47; width base/apex of pronotum:

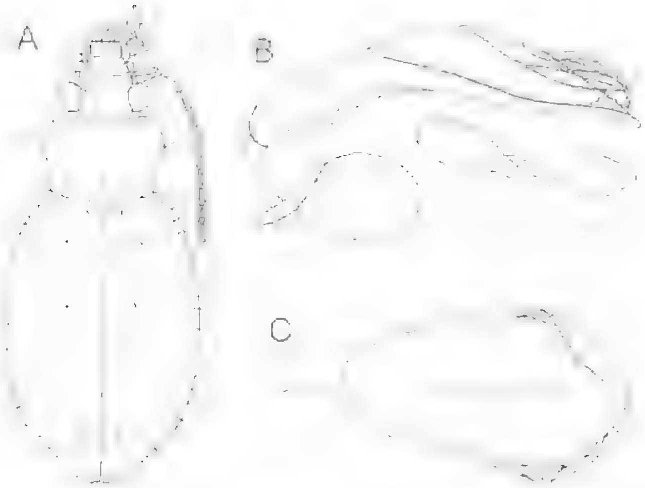

FIG. 1. *Euplynes decoloratus* sp. nov. A, habitus (length, 6.5mm). B, aedeagus and parameres. C, genital ring. Scale lines, 0.5mm.

1.19-1.24; length/width of elytra: 1.44-1.48; width elytra/pronotum: 1.61-1.68.

Colour. Head, pronotum, lower surface, and all appendages light reddish. Ground colour of elytra also light reddish, with rather slight bluish metallic lustre on basal two thirds or sometimes only in middle of basal half. Apical part light reddish, but even in specimens with more pronounced metallic hue the reddish apex not distinctly differentiated from colour of disk.

Head. Considerably narrower than pronotum. Eyes very large, semicircular, laterally far protruded. Frons with two circular grooves close to clypeal suture, in middle between eyes with a shallow, triangular groove. Labrum rectangular, 6-setose and with several shorter hairs around the anterior angles. Mandibles short and wide, at apex markedly incurved. Mentum with acute triangular tooth. Glossa bisetose, paraglossae surpassing glossa. Both palpi impilose. Antennae pilose from first third of fourth antennomere, elongate, surpassing humeri by about 3 antennomeres, central antennomeres slightly less than 3× as long as wide. Surface of head extremely finely and sparsely punctulate, highly glossy.

Pronotum. Wide, depressed. Apex slightly concave, anterior angles widely rounded, sides evenly curved, with a tiny sinuation in front of the sharp, slightly projecting basal angles. Base laterally markedly oblique. Apex and base not margined. Lateral channel wide though shallow. Median line rather fine, slightly impressed. Basal grooves shallow, somewhat linear. Anterior lateral seta situated at widest diameter, posterior seta at basal angle. Surface on disk impunctate, laterally and at base rather finely and sparsely punctate, highly glossy.

Elytra. Wide, depressed. Humeri widely rounded off, lateral margins feebly convex, lateral part of apex moderately sinuate, apex in middle almost transverse, with a tiny, obtuse denticle at suture. Striae complete, fine, slightly impressed, finely punctate almost to apex, intervals feebly convex. In basal half of elytra stria 3 slightly incurved to suture, and striae 5 and 6 markedly outturned to lateral margin, in this part with a deep, halfmoon-shaped groove that is deepest laterally. Interval 3 tripunctate, 1st and 2nd punctures at stria 3 in basal half, 3rd puncture close to apex near stria 2. Intervals impunctate and without microreticulation, highly glossy.

Lower surface. Metepisternum elongate, approximately twice as long as wide. Terminal sternite in male bisetose, in female quadrisetose.

Legs. Elongate. In both sexes tarsomere 4 of all tarsi deeply cleft and densely squamose. Anterior tarsus in male barely wider than in female, though tarsomeres 1 and 3 biseriately squamose beneath.

Male genitalia (Fig. 1B,C). Genital ring narrow and elongate, triangular, with elongate, asymmetric apex. Aedeagus elongate, lower surface slightly bisinuate, apex short, slightly curved down, gently triangular. Internal sac simply folded, without any sclerotisations. Both parameres rather circular, left one larger than right one.

Female genitalia (Fig. 2). Typical for *Euplynes*. Stylomere 1 with several short setae at inner apical margin. Stylomere 2 elongate, with elongate, acute apex and about 10 large, dentiform ventral ensiform setae. Near apex with a short nematiform seta. On dorsal surface with a short, dentiform, subapical dorsal ensiform seta. Lateral plate large, at median apical margin with a densely setose area.

Variation. Little variation noted apart from some differences in size and in distinctness and extent of the metallic lustre on the elytra.

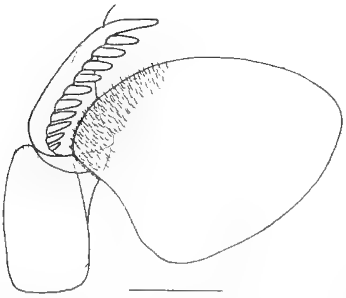

FIG. 2. *Euplynes decoloratus* sp. nov., ♀ stylomeres 1 and 2, and lateral plate. Scale line, 0.2mm.

DISTRIBUTION AND HABITAT. Iron Range, central Cape York Peninsula, northern Queensland. Most were collected by a pyrethrum knockdown technique on logs and tree trunk bases in lowland rainforest as described by Baehr (1995b). This observation is important as almost nothing is known about the biology of most other *Euplynes* species.

REMARKS. *Euplynes* is widespread in the Afrotropical and Oriental regions, where about 25 species occur. From neighbouring New Guinea only *Euplynes laetus* Darlington and *Euplynes apicalis* Darlington are recorded (Darlington, 1952, 1971). On the basis of body shape and colouration, especially the absence of a differently coloured, posthumeral elytral patch, the new species is apparently most closely related to *E. apicalis*.

This paleotropical genus was not previously recorded from Australia, though its occurrence at Iron Range is not surprising, because this area is well known for the large number of Oriental and Papuan faunal elements that do not occur elsewhere in Australia (Darlington, 1961, 1971). In contrast to the other new generic records presented here, this Australian representative of *Euplynes* has differentiated to full specific status. This could be evidence of immigration into Australia earlier than that of the following species.

Subfamily ODACANTHINAE
Dicraspeda Chaudoir

Dicraspeda longiloba (Liebke)

Dicraspeda longiloba Liebke, 1938: 83 (*Philemonia*).
Dicraspeda longiloba Darlington 1968: 212.

MATERIAL. 4♂, 2♀, West Claudie R., Iron Range, N Qld, 3-10.xii.1985, GM & DC, Pyrethrum knockdown/RF (QM, CBM); 1♂, Gordon Ck. Iron Range NP, NQ (QM).

REMARKS. *Dicraspeda longiloba* was originally described from New Guinea and later recorded from New Britain (Darlington, 1968). It is now recorded from Australia. The species is easily identified by the very elongate lobes of tarsomere 4 on all legs that are at least 3/4 the length of the whole tarsomere. *D. longiloba* is otherwise rather similar to *D. dubia* Gestro, a species also from New Guinea, and which has been recorded from Bamaga, at the extreme northern tip of Cape York Peninsula, by Darlington (1968) and Moore et al. (1987).

Discraspeda seems to be originally an old Australian faunal element. Several of its species, as well as of the closely related genera *Eudalia* Castelnau and *Renneria* Baehr, live in eastern and northern Australia (Moore et al., 1987; Baehr, 1999). However, the species group that includes *D. dubia* (Gestro) and *D. longiloba* (Liebke) — the former subgenus *Philemonia* Liebke — has the centre of its diversity and most probably also its origin in New Guinea where a number of rather similar species occur (Baehr, 1996a, 1997, 1998). This species group is progressive in certain morphological characters, e.g. the enlarged and deeply cleft tarsomere 4, the development of apical elytral spines, etc., and presumably it is derived from an old Australian stock. In New Guinea, even more apotypic species groups (or subgenera) and even related genera have evolved from the *dubia*-stock, e.g. the species of subgenus *Macerocentra* Chaudoir and genus *Crassacantha* Baehr (Darlington, 1968; Baehr, 1995a). Therefore, the occurrence of *D. dubia* and *D. longiloba* in Cape York Peninsula is most probably due to a recent re-immigration of these species into Australia from New Guinea.

The reported collecting circumstances ('pyrethrum knockdown in rainforest') support statements about the New Guinean species of *Dicraspeda* s.l. by Darlington (1968) and Baehr (1997). Both argue that the species obviously live in leaf litter of rainforest rather than near water, which is the typical habits of most other odacanthines. The change to life in rainforest litter thus may have been occurred in New Guinea during the evolution of the *dubia* species-group.

Lachnothorax Motschulsky

Lachnothorax tokkia Gestro

Lachnothorax tokkia Gestro, 1875: 856.
Lachnothorax tokkia Darlington 1968: 214.

FIG. 3. Map of Cape York Peninsula, showing localities mentioned in text. Position of dry barrier zone which separates rainforests of Cape York Peninsula from the Wet Tropics is shown.

MATERIAL. 6, Telegraph Crossing, Dulhunty R., Cape York Pen. N Qld. 2-4.VII.1975. GM (QM, CBM).

REMARKS. *Lachnothorax* is widespread in the Oriental region and is new to Australia. *Lachnothorax tokkia* has been recorded from New Guinea (Darlington, 1968) and is also distributed over much of the Indonesian Archipelago. Related species occur on the Asian mainland and on the Philippine islands (Baehr, 1996b).

Apparently *L. tokkia* lives on the sandy shore of rivers and lakes and the Australian record is also from a river in the northern part of the Cape York Peninsula. This species is also almost certainly a rather recent invader from New Guinea and the Oriental region.

Subfamily LEBIINAE

Catascopus Kirby

Catascopus moorei Straneo

Catascopus moorei Straneo, 1994: 164.

MATERIAL. 1♂, Cape York Qld/Cairns dist., J.A. Anderson/*Catascopus* 3819 Cape York (QM); 1♀. N Qld, Bamaga. 12.5.1993, M. Baehr (CBM).

REMARKS. This species was recently described from Iron Range, Cape York Peninsula (Straneo, 1994). This is probably the species that has been recorded under the name of *C. smaragdulus* Dejean from New Guinea (Darlington, 1968) and from Rocky Scrub and Iron Range in northern and central Cape York Peninsula, respectively (Darlington, 1968; Moore et al., 1987). The real *C. smaragdulus*, however, is a wholly Oriental species that probably does not reach New Guinea.

There are two new records of *C. moorei* from Australia and also new unpublished records from New Guinea. The Queensland Museum specimen cited above, however, is quite old according to the label. The rather vague locality record 'Cairns distr.' probably does not refer to the immediate vicinity of Cairns but rather to more northerly localities within Cape York Peninsula proper. The label statement 'Cape York' may even mean that it was collected at the true Cape York, right at the tip of the Peninsula, which is not far from Bamaga (Fig. 3).

Mochtherus Schmidt-Goebel

Mochtherus obscurus (Sloane)

Simurus obscurus Sloane, 1907: 183.
Mochtherus obscurus, Darlington, 1968: 123.

MATERIAL. 19, West Claudie R., Iron Range, N Qld, 3-10.xii.1985, GM & DC, pyrethrum knockdown/RF (QM, CBM); 2, 3km E of Lockerbie, Cape York, N Qld, 19-23.iii.1987, GM, pyrethrum on logs (QM).

REMARKS. *Mochtherus* is newly recorded from the Australian mainland, though a related species, *M. tetraspilotus* (Macleay), was recorded from Christmas Island (Moore et al., 1987). The latter species is very widely distributed over most of the Oriental Region. *Mochtherus obscurus* is widespread in New Guinea (Darlington, 1968) and is a typical rainforest dweller that lives on tree trunks and fallen logs. The collecting circumstances confirm these habits also for northern Australia. It is probably a rather recent immigrant into Australia from New Guinea. The new record once more strengthens the position of the Iron Range as a stronghold of Papuan-Oriental faunal elements.

Oxyodontus Chaudoir

Oxyodontus tripunctatus Chaudoir

Oxyodontus tripunctatus Chaudoir, 1869: 239.
Oxyodontus tripunctatus Darlington, 1968: 122.

MATERIAL. 2, West Claudie R., Iron Range, N Qld, 3-10.xii.1985, GM & DC, pyrethrum knockdown/RF (QM, CBM).

REMARKS. The monotypic *Oxyodontus tripunctatus* is widespread throughout the Oriental and Papuan regions (Darlington, 1968). It lives in the same manner as the foregoing species and has been collected in the same area using the same method. Both genus and species are likewise new to Australia.

DISCUSSION

Philip J. Darlington Jnr first drew attention to the important role of the rain forest blocks of Cape York Peninsula as gateways for Oriental rainforest Carabidae migrating into Australia (Darlington, 1961, 1971). The names he used for the different rainforest blocks were: 'Tip-of-Peninsula' for the small rainforest patches near Bamaga and Lockerbie just south of Cape York, itself; 'Mid-Peninsula', for those at McIlwraith Range (including Rocky Scrub) and Iron Range near the eastern coast half way down the peninsula; and 'Base-of-Peninsula' for those substantial tropical rainforests that stretch from about Cooktown south to Townsville, and which we now know as the 'Wet Tropics'. These separate rainforest systems are separated by wide bands of open, drier, sclerophyll forest. Wider discussion and further evidence of the important biogeographic role of these Cape York Peninsula rainforests was given by Kikkawa et al. (1981).

The new records from Australia, presented here, of genera and species widespread in the Oriental and Papuan Regions, corroborate this important role of Cape York Peninsula. They further raise the proportion of Oriental taxa in the major rainforest blocks at the northern tip and in the centre of Cape York Peninsula. These increasingly prove to be outliers of the Oriental fauna on the Australian continent and have very few endemic Australian faunal elements. Indeed, the large rainforest-inhabiting carabid genera of endemic Australian origin, such as *Pamborus*, *Philipis*, *Leiradira*, *Castelnaudia*, *Trichosternus*, *Nurus* and *Notonomus*, are not present at all in the central and northern Peninsula rainforests. Instead, they have their northern limits in the Cooktown-Mt Finnigan area at the base of Cape York Peninsula, or even further south (*Nurus*). Only a few small, rather peculiar, genera, that are derived from the southern endemic genera, occur in the mid-Peninsular and tip-of peninsula rainforests, namely *Paranurus* and *Notabax* in the mid-Peninsula forests, and *Paranurus* and *Mecynognathus* in the tip-of-Peninsula rainforests. They are probably secondary immigrants into Cape York Peninsula from the south that arrived when the climate was wetter during last glaciation period, and when the sclerophyll forest barriers were not as wide or as powerful as they are today. At least some species of *Paranurus* have adapted to life in open forest rather than rain forest.

Conversely, many carabid genera and species of Oriental origin, including those reported here, do not penetrate further south than the Iron Range rainforest block in the mid-Peninsula zone. This is probably the consequence of their very recent immigration into Australia, and their inability to cross the wide corridor of open forest at the base of Cape York Peninsula that opened, or at least has widened, since end of last glaciation period (Fig. 3). These distribution patterns in the Peninsula, as noted for the Carabidae, have been shown to be identical in other groups of rainforest insects, such as the aradid bark bugs (Monteith, 1997).

ACKNOWLEDGEMENTS

I heartily thank Dr G. Monteith, of the Queensland Museum, for the kind loan of the material studied and for the opportunity to work through the rich collections of unidentified carabid material collected by him and his co-workers in many interesting habitats of northern Queensland over the last 30 years.

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LAMPYRIDAE OF AUSTRALIA (COLEOPTERA: LAMPYRIDAE: LUCIOLINAE: LUCIOLINI)

L.A. BALLANTYNE AND C. LAMBKIN

Ballantyne, L.A. & Lambkin, C. 2000 12 31: Lampyridae of Australia (Coleoptera: Lampyridae: Luciolinae: Luciolini). *Memoirs of the Queensland Museum* **46**(1): 15-93. Brisbane. ISSN 0079-8835.

The flashing firefly fauna of Australia (Lampyridae: Luciolinae: Luciolini) is revised recognising 25 species in 4 genera. All genera are keyed from males and redescribed. All species are keyed from males, and from associated females and larvae. Existing species are redescribed and 8 new species described. Newly associated females and larvae are described. Species distributions are recorded and mapped. *Luciola* subgenus *Luciola* includes 6 species: *australis* F., *cowleyi* Blackburn, *dejeani* Gemminger, *flavicollis* MacLeay, *nigra* Olivier (the last two have larvae described), and *orapallida* sp. nov. which is described from males, females and larvae. *L. dejeani* may not be Australian and its status is discussed. *L. scutellaris* Lea and *L. humilis* Olivier now stand under *Luciola nigra* Olivier. The type specimen of *L. australis* is reconsidered. *Atyphella* Olliff comprises 23 species including 7 new: *atra* Lea, *brevis* Lea, *conspicua* sp. nov., *ellioti* sp. nov., *flammans* Olliff, *flammulans* sp. nov., *immaculata* sp. nov., *inconspicua* (Lea), *lewisi* sp. nov., *lychnus* Olliff, *majuscula* (Lea), *monteithi* sp. nov., *olivieri* Lea, *scintillans* Olliff, *similis* sp. nov.; *costata* (Lea) is transferred to *Atyphella* from *Luciola*. Females are described for *atra*, *costata*, *flammans*, *inconspicua* and *olivieri*, and larvae for *atra*, *flammans*, *majuscula*, *olivieri* and *scintillans*. The following non-Australian species are assigned to *Atyphella*: *aphrogeneia* (Ballantyne), *carolinae* Olivier, *huonensis* (Ballantyne), *leucura* Olivier, *marginipennis* (Guérin), *obsoleta* Olivier, *wolfi* (Olivier). *Pteroptyx* Olivier is represented by *P. cribellata* Olivier and *P. platygaster* (Lea), raised from synonymy with *P. cribellata*. *Pyrophanes* Olivier in Australia is based on *P. beccarii* Olivier, under which *Luciola complicata* Lea is synonymised. Lectotypes are designated for *Atyphella brevis*, *A. flammans*, *A. inconspicua*, *A. lychnus*, *A. majuscula*, *A. olivieri*, *A. scintillans* and *Pteroptyx platygaster*. The first phylogenetic analysis undertaken on the Luciolinae reveals preliminary directions for its taxonomy. The status of the genus *Atyphella* Olliff is supported and is expanded here. A *Luciola*/*Pteroptyx* clade includes species of 6 genera (*Pteroptyx*, *Pyrophanes*, *Colophotia*, *Lampyroidea*, *Bourgeoisia*, and 2 subgenera of *Luciola*) and needs to be addressed from a wider perspective before definitive changes are made. Nine Australian species identified in this clade are assigned to existing genera. Initial cladistic analyses could not be completed because of a computer program limitation on the number of most parsimonious trees that could be saved. Several methods to overcome the problem of large numbers of most parsimonious trees, generated because of the high proportion of missing larval and female data in the matrix, are investigated. The significance of female aptery, morphological adaptations of the male and their behavioural significance, the nature of the labrum, distribution and possible origins of the Australian fauna are also discussed. ☐ *Insecta, Coleoptera, Lampyridae, Luciolini, Australia, taxonomy, behaviour, morphology, phylogeny, missing data.*

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The Australian Lampyridae are all flashing fireflies (i.e. males and females have light organs, which are used to attract the sexes for mating). They occur mainly along the eastern seaboard of Australia from Cape York Peninsula to the Illawarra region in New South Wales (Moore, 1989) in a discontinuous pattern paralleling for the most part rainforest or mangrove regions. This distribution and the paucity of species relative to New Guinea reflect the discontinuous rainforest pattern. A few species occur across northern coastal Australia (Northern Territory and Gulf of Carpentaria) but nothing is known of their ecology. Fireflies are restricted by a combination of temperature and humidity, partly because of their soft exoskeleton, but also because these conditions affect the distribution of their food source, which is mainly small land snails and slugs.

Twenty-five species and 4 genera are treated here. A single female from Murray I. in Torres Strait is an outlier representative of a basically New Guinea species and it is more appropriate for its formal taxonomy to be dealt with in the broader treatment of the whole New Guinea fauna (Ballantyne, in prep.). It is included here in the key to females of *Luciola* only, as *Luciola* species A.

The Australian fauna is exclusively Luciolinae, a subfamily distributed around the warmer parts of the world except for South America, and distinguished by the possession of only 6 visible abdominal sternites in the male and the loss of abdominal sternite 8. There is no similar loss in the female. Ballantyne (1987a,b) discussed abdominal segmentation in Luciolinae; the 6 visible abdominal sternites belong to actual segments 2-7, with the light organs in the male on sternites 6 and 7, and in the female on sternite 6 only. Since abdominal sternite 8 is lost in the adult male, the visible terminal segments are thus sternite 7 and tergite 8. Remnants of sternite 1 may occur at the base of the abdomen as small, lateral, slightly sclerotised plates in an otherwise membranous area (Ballantyne, 1992).

This study defines species by morphological features, using all life cycle stages when available. Little information is available on the light patterns, shown by McDermott (1910) and Lloyd (1966) to be important in enabling accurate species differentiation. A few studies in the Australasian and Indomalaysian areas have thus far characterised fireflies by behavioural (viz. flashing data) as well as by more conventional means (Ballantyne & McLean, 1970; Lloyd, 1972, 1973b; Ballantyne & Buck, 1979; Ballantyne, 1987a). However those studies indicate the usefulness of an initial taxonomic study to guide behavioural work (e.g. Ballantyne & McLean, 1970) and of a morphological re-evaluation once light patterns are known (e.g. Ballantyne, 1987a). Since a similar approach is expected here label data is quoted in full to allow accurate relocation of all specimens examined, and any consistent variability in features such as colouration is noted with the specimen listing.

Calder (1998) catalogued the Australian Lampyridae following Ballantyne (1992) and presented an historical overview.

None of the Australian genera treated here is endemic and two, *Pteroptyx* and *Pyrophanes*, are represented in Australia by very few species. Cladistic analysis of relationships based on only Australian species would be limited; instead, a wider interpretation is attempted using 43 lucioline taxa. While this analysis supports the retention and extension of the genus *Atyphella*, relationships of the other three genera remain problematical. The Australian species are therefore assigned to four existing genera and subgenera, and redescribed from their Australian representatives only. However we anticipate that as certain groups are more thoroughly investigated other genera and subgenera will be defined.

Ballantyne provided the taxonomic descriptions and all figures and is to be regarded as the sole author of the new species. Lambkin undertook the cladistic analysis and wrote the section on phylogeny based on information provided by Ballantyne.

MATERIAL AND METHODS

This study examined over 3,000 specimens including over 200 holotypes, lectotypes and paratypes. Most original specimens studied are in the Queensland Museum. Specimens in Australian collections were identified during 1997-1999.

Types if located were re-examined. Their identity was not always clear from the labels and LB followed Calder (1998) and the original descriptions in determining their status. Some confusion is overcome by lectotype designation.

Most adult specimens examined during this study have been pinned. Some live specimens were killed, fixed and preserved in 70% ethanol. Such treatment made manipulation and dissection easier, but colour patterns may be obscured by the increased transparency of the elytra and pronotum; some shape distortion occurred; the extent of some light organ material became unclear, especially if the specimen was pinned after being in alcohol.

Larvae were killed, fixed and preserved in 70% ethanol. Many larvae examined were collected over 30 years ago and some had been described (Powell, 1964); re-examination revealed some colour fading. Freshly collected and preserved larvae were described where possible.

The Dept. of Zoology and Entomology at the University of Queensland houses a large collection of alcohol preserved Lampyridae in tubes numbered with prefix 'T'.

An important component of the collections studied is the numerous fireflies collected in the Wet Tropics Zone of North Queensland by Queensland Museum personnel since 1980 under the leadership of Dr G.B. Monteith. This intensive survey attempted to systematically collect all the rainforested mountain systems of this complex, high-rainfall, subcoastal region between Cooktown and Townsville. Monteith (1995) divided the Wet Tropics into 19 mountain blocks, each separated by natural barriers and/or dry corridors. These were used by Baehr (1995) in his analysis of the carabid genus *Philipis* and are employed herein (Figs 9, 10, 11 and 13).

SPECIMEN LISTS. These are given in a standard format as follows. The first entry for TYPE gives full label data for primary type/s, with deposition, registration number, whether examined and lectotype procedures. For new species all additional specimens are made paratypes. Under the heading MATERIAL all specimens are summarised. An initial statement gives total numbers. Specimens are listed by Australian state with Queensland divided into northern (N QLD: north of Bowen), central (C QLD: Gladstone to Bowen) and southern (S QLD: south of Gladstone) sectors. Localities are listed from north to south. Data is listed in sequence: latitude, longitude, locality name, date, collector/s, museum deposition. The locality is not repeated for separate collections from same locality, and museum deposition is only entered when it changes from last citation.

ABBREVIATIONS. *Collection Repositories.* LB is grateful to the following institutions from which collections were borrowed. They are listed with their abbreviation used and the curators with whom LB dealt: AM, Australian Museum, Sydney (M. Moulds); ANIC, Australian National Insect Collection, CSIRO Canberra (T. Weir); BPBM, Bernice P. Bishop Museum, Honolulu, USA (A. Samuelson); BMNH, Natural History Museum, London (J. Beard); CAS, Californian Academy of Sciences, San Francisco; DPI, Dept. of Primary Industry, Mareeba, Queensland (R. Storey); UQ, Dept. of Zoology and Entomology, University of Queensland (M. Schneider); MAGNT, Museum and Art Gallery of the Northern Territory (G. Brown); MM, Macleay Museum, University of Sydney (D.S. Horning); MCG, Civic Museum, Genoa, Italy (R. Poggi); MNHP, Muséum National d'Histoire Naturelle, Paris, France (J. Ménier); MV, Museum of Victoria, Melbourne (K. Walker); OTT, National Museum of Natural Sciences, Ottawa (F. Génier); QM, Queensland Museum, Brisbane (G. Monteith); SAM, South Australian Museum Adelaide (E. Matthews).

Collectors. EB, Ev Britton; GB, George Brooks; CB, Chris Burwell; BC, Bryan Cantrell; IC, Ian Common; DC, Doug Cook; HH, Henry Hacker; HJ, Heather Janetzki; SH, Simon Hamlet; JL, John Lawrence; DKM, David McAlpine; GBM, Geoff Monteith; SRM, Sybil Monteith; LP, Lesley Powell (married name Ballantyne); RS, Ross Storey; GT, Geoff Thompson; MU, Murray Upton; JLW, Lea Wassell; TW, Tom Weir; DY, David Yeates; AWH, A.Walford-Huggins; PZ, Paul Zborowski

Descriptions. ASD, distance between antennal sockets; ASW, greatest diameter antennal socket; EO, ejaculatory orifice aedeagus; FS, antennal flagellar segments; GHW, greatest head width, across eyes, measured parallel to ASD; LL, lateral lobe aedeagus; MFC, metafemoral comb; ML, median lobe aedeagus; MPP, median posterior projection sternite 7; MS, mesoscutellum; SIW, smallest interocular width (measured parallel to ASD, ASW).

Other Abbreviations. FIT, flight intercept trap, NP, National Park; PF, pitfall; RF, rainforest; SF, State Forest.

Latitude and longitude are abbreviated e.g. 17.15S = 17 degrees 15 minutes south.

MEASUREMENTS. Dimensions (in mm) should not be taken as absolute as most Lampyridae are soft bodied and subject to distortion. Measurements are further affected by the condition and age of the specimen, whether wet or dry preserved, and any delay between capture and killing. Except for total length, most dimensions are used comparatively as indicated below.

Length of pronotum is median length; width of pronotum is measured at the widest region. The length of winged specimens is sum of median lengths of the elytron and pronotum. As the pronotum tends to droop in pinned specimens their total length will usually appear to be slightly shorter than the figure given. The head is not included in overall body length because it may or may not protrude in front of the pronotum. Brachelytral female length is median length of the pronotum plus an estimation of the non-extended length of the rest of the body (most of the brachelytral females measured are quite gravid). For larvae the dimensions of the protergum and the relative length of abdominal and thoracic terga is less subject to variation than absolute length.

Adult head measurements refer to the anterior aspect. Greatest head width (GHW) is taken horizontally across and including the eyes at the widest point. Smallest interocular width (SIW) is taken between the eye edges, just above the antennal sockets. The smallest distance separating the antennal sockets (ASD) compared to the width of a socket (ASW) is more useful than the absolute measurement of either.

Larval head length is median length of the frontoclypeus; width is maximum dorsal width (not including the simple eyes if they protrude beyond the lateral head margins).

DISCUSSION OF CHARACTERS. Characters and dissection methods follow Ballantyne & McLean (1970) and Ballantyne (1987a). For convenience some are repeated. The taxonomy is male-based as difficulties exist in associating the sexes unless taken *in copula*. Female characters are described only when they differ from those of the male. Wherever possible features are described comparatively (e.g. elevation of elytral interstitial lines is related to sutural ridge elevation; proximity of the antennal sockets is a function of their diameter).

Pronotal width is characterised: width across posterior third either subequal to (Fig. 19C-E), narrower than (Fig. 19A) or wider than (Fig. 1A-D,F,G,I-L, Fig. 19B) width across anterior third. Lateral pronotal margins are: subparallel (Fig. 19C), divergent along at least anterior half (Fig. 1A-D,F,G,I-L), divergent along their length, or pronotum is widest across the middle and lateral margins converge anteriorly and posteriorly (Fig. 1E,H). Anterolateral corners are rounded, often obtusely (e.g. Fig. 1A-D), or pointed (Ballantyne, 1968: fig. 120). Posterolateral corners are rounded (Fig. 1A-L), or approximately right-angled (Fig. 19C,E). An explanate lateral margin may be wider in the posterior half, or not

A maximum of 4 elytral interstitial lines is numbered 1 (nearest suture) to 4 (nearest lateral margin). Well defined interstitial lines are elevated and thickened at least as much as the sutural ridge; evanescent lines are scarcely if at all elevated, often obliterated anteriorly and posteriorly. Degree of development of interstitial lines is further compared one to the other on the same elytron.

The shape of the deflexed elytral apex uses comparisons of lengths across the posterior margin of the deflexed apex, the outer (epipleural) margin, and the inner (sutural) margin (see Fig. 20K). The elytral epipleuron and a distinct sutural ridge may extend along all or part of the margin to the apex.

The relative size, depth and approximation of punctures on the pronotum and the elytra can be ascertained under high power of the stereo dissecting microscope (× 40).

McDermott (1964) distinguished the Photurinae with a 'membranous labrum arising from the ventral surface of a strongly sclerotized clypeus'. The nature of the labrum was reinterpreted by John Lawrence (ANIC): in the cantharoids there is probably never a well developed clypeus separated from the frons by a complete frontoclypeal suture. In most Lampyridae the labrum is at least slightly sclerotised and separated from the clypeus by a strip of membrane. In most Luciolinae the labrum is free. The anterior strongly sclerotised plate on the Photurinae head is here interpreted as the labrum.

Proximity of eyes above the labrum (SIW/GHW) is measured as close (1/6–1/15), moderately (> 1/6 but < 1/2), or widely separated (1/2 -1/3). Separation of eyes on the ventral head surface is measured just behind mouthpart complex relative to the GHW measured at the same point. In *Atyphella*, a junction between the frons and the vertex may be conspicuous and acutely margined or rounded (Fig. 2C,F,G,I), or not clearly evident (Fig. 2A,D,H). Frons height is measured from the top of the antennal sockets to the middle of the frons/vertex junction relative to the antennal socket width (ASW). Depression of the vertex is minimal (barely excavated if at all), or moderate to deep. A posterior excavation of the eye if present is visible from the side (Ballantyne, 1968: figs 144, 147-150).

In the Luciolinae the head may be concealed from above by retraction into the cavity beneath the pronotum; lateral margins even if explanate do not contribute to this concealment. In *Photuris* spp. (considered here as an outgroup) the head is too large to be retracted into the pronotal cavity and the explanate anterior and lateral margins contribute to head concealment. The Luciolinae head is either greatly exposed (the head cannot be retracted into the pronotum), slightly (some of the posterior head is retracted beneath the pronotum) or completely concealed (not visible from above). Mouthparts are small and probably non-functional when antennal sockets are contiguous and mandibles and palpi are reduced.

Ballantyne (1987a: 119) characterised abdominal features including the ventral face of tergite 8 and light organ area, which are used here. Tergite 8 may bear ventrally a 'longitudinal trough' housing the aedeagal sheath, and margined laterally by elevated longitudinal 'ridges'; the area lateral to the ridges may be flat (Fig. 20C) or depressed ('lateral troughs') (Fig. 26C,D). Ballantyne (1987a: 119) defined 'flanges' as 'variable shaped paired projections (that) arise from the anteromedial area of the lateral margins (of the downturned lateral margins on the ventral face of tergite 8)'; these partially enfold the aedeagal sheath in its resting position. Flanges are redefined here as: distinctly prolonged structures at the anteromedial area of the downturned lateral margins of tergite 8, separated from the rest of the downturned lateral margin by some narrowing at their bases; apically rounded or pointed, broad or narrow, sometimes asymmetrical. As redefined *Luciola australis* F. (Ballantyne, 1988) does not possess flanges.

A median longitudinal carina and/or 'trough' may occur between light organ halves in sternite 7 (Ballantyne & McLean, 1970: fig. 3D,G,F) and a depression ('dimple') anterior to the MPP (Fig. 20K). Developments along sternite 7 posterior margin are: a median posterior projection (MPP) may be developed (Fig. 3A-D, F, J; Fig. 4C, H; Fig. 20A,D,G,J; Fig. 26A); LPP are posterior projections of the postero-lateral corners of sternite 7 (Fig. 20J,M; Fig. 26A,B); incurving lobes and pointed projections may occur (Fig. 26A).

Female head form variability correlates with the extent of elytra (and consequently flight ability) and is referred to Figure 6. Winged females' heads are similar to those of the males except for smaller eyes and a slighter depression of the vertex; the head may be exposed or concealed beneath the pronotum, and mouthparts are always well-developed (Fig. 6B). Brachelytral females have very small concealed heads, small widely separated eyes, widely separated antennal sockets, a shallowly depressed vertex, and the anterior portion of the head capsule in front of the eyes and including the antennae, is prolonged anteriorly (Fig. 6D,E). Mouthparts may be functional or not.

Reliable sex associations are made by taking specimens *in copulo*. Tentative assignments of females may be made on the basis of label data only; these are so indicated in the descriptions. It is reasonable to assume conspecificity where males of only one species are flying and females are observed flashing in apparent response to them. When such associations are made it is so indicated in the descriptions. Larval associations are confirmed by rearing unless indicated otherwise.

All descriptions are ordered in that the entire dorsal surface is examined first and then the ventral, facilitating examination of specimens. Specimens thus do not have to be repeatedly turned.

GENITALIA PREPARATION. The method of extraction of the aedeagus described in Ballantyne & McLean (1970: 229-230) was modified to preserve the integrity of the aedeagal sheath and to allow observation of the ventral face of tergite 8. The abdomen of pinned specimens was removed and softened. Terminal tergites and sternites were separated along the membranous lateral line and the tergites folded back to allow examination of the nature of the ventral face of tergite 8 and the dorsal face of the aedeagal sheath, which could then be left in place. Longitudinal muscles arising on the anterior prolongation of the aedeagal sheath sternite (Ballantyne, 1987b: fig. 2H) and which insert in the base of the aedeagus were then severed. The aedeagus was extracted by pulling it carefully in an anterior direction, grasped by fine forceps. Dried specimens were rehydrated and the aedeagus pulled from the body making it visible but still attached; this did not however allow observation of the nature of the aedeagal sheath.

MORPHOLOGY OF LAMPYRIDAE

This morphological discussion is based on Australian representatives.

Soft bodied, somewhat flattened insects. Adults with pale luminescent organs beneath the 5th visible, or actual 6th abdominal sternite in the female, and beneath the 5th and 6th visible, or actual 6th and 7th abdominal sternites, in the male. Pronotum pale coloured, usually orange, or cream, often with median dark markings; elytra often semitransparent if pale; sometimes pale yellow or orange with terminal dark markings; otherwise pale or dark brown, sometimes with paler orange or yellow basal, and/or lateral and/or sutural margins; interstitial lines often paler than rest of elytron.

MALE. Pronotum often with lateral margins explanate and flattened; in *Atyphella* wider than long (W/L 1.5-2.6) with anterolateral corners usually rounded and lateral margins often diverging posteriorly (Figs 1, 2); in *Luciola*, *Pteroptyx* and *Pyrophanes* not much longer than wide (W/L

1.2-2.0), lateral margins not diverging posteriorly and approximately subparallel (Fig. 19 A,C-E). Legs with flattened tibiae lacking apical spurs; tarsi 5 segmented, with 4th tarsomere bilobed and 5th elongate, slender and entire; tarsi with 2 basally toothed entire claws at apex; hind tibiae curved and hind femora swollen and curved in *Pyrophanes*, not so in *Atyphella*, *Luciola* and *Pteroptyx*. MFC present in *Pyrophanes* (Fig. 26H); absent in *Luciola*, *Atyphella* and Australian *Pteroptyx* (Ballantyne, 1987a). Elytra with short, often dense pubescence; elytral epipleura broad at base; elytra covering abdomen completely at rest; a maximum of 4 interstitial lines barely discernible or variously developed; apex deflexed in *Pteroptyx*; hind wings fully developed and all males presumed capable of flight. When viewed from above the head may be completely covered, or at least part of head is covered by pronotum in withdrawn condition in many *Atyphella* (Figs 1, 2), or head may be incapable of being covered by pronotum in withdrawn condition in *Luciola*, *Pteroptyx* and *Pyrophanes*, where less than 1/3 of head is covered; the comment 'head is concealed by explanate pronotum' (Lawrence & Britton, 1991: 640) does not refer to Australian species where the head cannot be concealed in many species, or only the lateral pronotal margins are explanate and do not contribute to concealing the head from above; eyes very large, often closely approaching ventrally in *Atyphella* and almost contiguous ventrally in *Luciola cowleyi*; ocelli absent; antennae filiform, 11 segmented (less than 11 segmented in some *A. scintillans* and *A. ellioti*) and inserted at front of head just above the labrum; antennal length 1-2 × GHW; antennal sockets close, often contiguous, never separated by more than twice ASW; labrum separated from clypeus by suture, labrum small and about as wide as long in *Atyphella* (Fig. 2), and about twice as wide as long in *Luciola*, *Pyrophanes* and *Pteroptyx*; clypeus indistinct, frons reduced, most of head area between eyes represented by the vertex, which is often deeply depressed; (head capsule interpreted from Stickney, 1923). Mouthparts very hairy and usually well developed although adults may not feed; mandibles curved, perforated by a canal, acutely pointed at apices, which cross at rest; mandibles with a well developed hairy prostheca at their inner basal angle; maxillae densely hairy, palpi 4 segmented with enlarged apical segment; all areas recognisable although galea and lacinia are imperfectly separated; labium with mentum and submentum small and weakly demarcated; palpi 3 segmented, apical segment much smaller than apical segment of maxillary palpi, and slender and elongate in most *Luciola*, *Pteroptyx*; laterally compressed with inner margin excised in some *Atyphella*. Abdomen with 6 visible sternites belonging to actual segments 2-7, and light organs beneath sternites 6 and 7; abdominal sternite 1 appears as paired lateral islands of cuticle in *Pteroptyx*, and is hidden by the hind coxae at rest (Fig. 20J; Ballantyne, 1987a); light organ entire in sternite 6 although retraction from lateral and posterior margins may be a postmortem change; light organ entire in sternite 7 in *Luciola*, *Pteroptyx* and *Atyphella* (Figs 3, 4, 20), although often retracted into anterior half in *Luciola* and *Pteroptyx*; light organ bipartite in sternite 7 in *Pyrophanes* (Fig. 26). Posterior margin of sternite 7 variously developed and described in detail here and in Ballantyne (1987b). Aedeagal sheath (Fig. 21) lacking lateral protuberances (paraprocts) except in *Pyrophanes*. Aedeagus a simple elongate, often slender, structure comprising median and lateral lobes with no accessory processes and a simple membranous basal piece (Figs 5, 21).

FEMALE. Macropterous and presumed capable of flight (unless female is very gravid) in some *Atyphella*, and all known *Luciola*, *Pteroptyx* and *Pyrophanes*. Elytra and hind wings variously reduced in some *Atyphella*, females never completely wingless, and apices never deflexed. Head always covered by pronotum at rest, eyes smaller than those of males (Fig. 6). In *Luciola* and macropterous *Atyphella* females the eyes are little reduced, the GHW is always > twice SIW, and the mouthparts insert close to the anterior eye margin (Fig. 6B); in brachelytral *Atyphella* the eyes are much reduced, the GHW is about 2 × SIW, and the head is prolonged beyond the anterior eye margins (Fig. 6D,E). Mouthparts usually well developed. MFC absent and no legs with swollen or curved segments. Light organs entire beneath sternite 6 only, although sternite 7 may bear pale fat body patches. Abdomen with 7 visible sternites (segments 2-8), tapering posteriorly.

LARVA. Elongate, slender, tapering somewhat in front and behind; 3 thoracic and nine abdominal segments; terga more heavily sclerotised than venter; all body segments except the last with a median dorsal longitudinal groove (Figs 7, 12, 15); and laterally explanate in *Atyphella*, but not so in *Luciola*, coloured cream, yellow and/or brown. Head when retracted invisible beneath pronotum; with a single simple eye on each side. The meso- and metathoracic sterna comprise (Fig 7) an anterior 'complementary segment', bearing spiracles, and a posterior leg bearing area; (the complementary segment has no intrinsic segmental muscles or other segmental structures and is a fold of the sternal integument not extending to the terga — Martin (1916) attributed it to the segment in front); ventrolateral sutures delimit epipleural areas on all but the terminal segment. The meso and metathorax bear 2 epipleural areas per segment, the anterior plate bearing the spiracles. Each sternal area of abdominal segments 4-11 carries laterally narrow paired pigmented epipleural areas of which the most lateral bears the spiracles; complementary segments are absent; light organ present beneath abdominal segment 11 (i.e. penultimate) and the light is visible from above and below; abdomen terminated by a series of eversible filaments or pygopods (Domagala & Ghiradella, 1984).

Powell (1964) described larval morphology for certain *Luciola* species, Ballantyne & Buck (1979) the larva of *Luciola aphrogeneia*, (assigned here to *Atyphella*) and some aspects of larval morphology of *Luciola pudica* (= *L. australis*). Non-Australian *Pteroptyx* and *Pyrophanes* larvae lack laterally explanate tergal margins (Ballantyne & McLean, 1970; Ballantyne, 1987a,b; Blair, 1927).

BIOLOGY OF LAMPYRIDAE

Larvae and pupae faintly luminous; the larval light a continuous glow visible equally well from either surface; extinguished if the larva is disturbed; luminosity of eggs not observed. Sivinski (1981) suggested certain adaptive significances of the larval light. In adult males the light is emitted from special light organs on visible sternites 5 and 6, and in the female from the visible 5th sternite. Light is under nervous control and is emitted in a series of controlled flashes in both sexes; in North American and New Guinean species, there exists a complex dialogue in male flash pattern and duration, and female response, which serve as a means of attracting the sexes and maintaining species identity (review of light production in Lampyridae, Lloyd 1971, 1973b, 1977). Preliminary observations suggest the same is true of Australian fireflies. Australian species are restricted to moist areas (e.g. mangrove river flats, rainforest and relict rainforest) which will maintain a population of small land snails, on which the larvae have been observed to feed. In European species the larval prey is paralysed by injection of the secretion of a pair of acinose glands at the anterior end of the alimentary canal, through the tubular, sharply pointed mandibles. The larva imbibes the liquefied tissues of the prey. Larvae of *Luciola australis* appear to use their abdominal filaments to aid in forward progression; the terminal segment of the abdomen is brought forward under the more anterior segments (while the filaments are partly exserted) in the manner reminiscent of a looper caterpillar (Lepidoptera: Geometridae) (Powell, 1964).

ARRANGEMENT OF TAXA IN THE LUCIOLINAE

The Luciolinae is treated here in the form devised by McDermott (1966) (with subsequent additions in bold type).

LUCIOLINAE
LUCIOLINI

Atyphella Olliff (restored to generic level by Ballantyne in Calder, 1998)

Type species *Atyphella lychnus* Olliff

Bourgeoisia Olivier

Type species *Luciola antipoda* Bourgeois

Colophotia Dejean

Type species *Lampyris praeusta* Eschsch.

Luciola Laporte

Subgenus *Luciola* s. Str.

Type species *Luciola pedemontana* Mots. 1853

Subgenus *Hotaria* Yuasu 1937

Type species *Luciola parvula* Kiesenw. 1874

Subgenus *Photuroluciola* Pic

Type species *Photuroluciola deplanata* Pic 1931

Subgenus *Pygoluciola* Wittmer

Type species *Pygoluciola stylifer* Wittmer 1939

Subgenus *Pygatyphella* Ballantyne 1968. Two species of this subgenus including the type species *obsoleta* Olivier are assigned to *Atyphella*. The remaining species are yet to be investigated.

Lampyroidea Costa

Type species *Lampyroidea syriaca* Costa 1875

Pteroptyx Olivier

Type species (see discussion)

Pyrophanes Olivier

Type species *Pyrophanes similis* Olivier

Curtosini

Curtos Motschulsky

Type species *Curtos mongolicus* Motschulsky

KEY TO AUSTRALIAN GENERA USING ADULT MALES

1. Elytral apices deflexed (Fig. 20J,K) . . *Pteroptyx* Olivier
   Elytral apices not deflexed 2
2. Metafemoral comb present (Fig. 26H); light organ bipartite in sternite 7 (Fig. 26A); aedeagal sheath symmetrical, bearing paraprocts (as in Fig. 21B); lateral lobes of aedeagus about 4/5 length of median lobe and fused for most of their dorsal length and apices not visible ventrally (Fig. 26E-G) . . . *Pyrophanes* Olivier
   Metafemoral comb absent; light organ entire in sternite 7; aedeagal sheath symmetrical or not, but never bearing paraprocts; lateral lobes of aedeagus at least 7/8 length of median lobe; apices sometimes visible ventrally . . . 3
3. Posterolateral angles of pronotum acute, lateral margins subparallel (Fig. 19A,C-E); elytral interstitial lines poorly defined (except in *L. cowleyi*); head never completely concealed by pronotum at rest; posterior half of aedeagal sheath sternite symmetrical, anterior prolongation of sheath sternite narrowly tapered; (Fig. 21C-H); aedeagus either: elongate slender, median lobe slightly longer than apices of lateral lobes which are not visible ventrally (Fig. 21O-W), or aedeagus with median lobe much shorter than lateral lobes which are broad in their basal 1/2 and narrowed in their apical 1/2 (Fig. 21K), or aedeagus with median lobe only a little shorter than lateral lobes which are broad in their basal 3/4 and closely approximate dorsally, with their apices narrowed and widely separated in their apical 1/4 (Fig. 21L-N) . . . . *Luciola (Luciola)* Laporte
   Posterolateral angles of pronotum rounded, lateral margins diverging posteriorly except in *A. inconspicua* where they are subparallel; at least 2 elytral interstitial lines well defined; head often largely covered by pronotum at rest; posterior half of aedeagal sheath sternite asymmetrical (Fig. 21I,J), anterior prolongation broadly tapered; aedeagus with apices of lateral lobes never acutely narrowed and always visible ventrally; median lobe always slightly longer than lateral lobes (Fig. 5) . . . . *Atyphella* Olliff

Atyphella Olliff, 1890

Atyphella Olliff, 1890: 645. Lea, 1909: 110; Olivier, 1909b: lxxxii; 1910: 40; 1911a: 171; 1913: 417; McDermott, 1964: 45; Ballantyne, 1987b: 172, 175-77, 181, 183-5. Calder, 1998, 176.

Luciola (Luciola) Laporte, sensu McDermott, 1966: 99.

Luciola (Atyphella) (Olliff). Ballantyne, 1968: 108. Ballantyne & McLean, 1970: 236.

TYPE SPECIES. *Atyphella lychnus* Olliff, 1890, designated by Wittmer, 1958.

DESCRIPTION. MALE. This treatment extends Ballantyne & McLean (1970). Dorsal surfaces more or less conspicuously punctate, and moderately pubescent.

Pronotum. Width/length 1.5-2.6, always wider than long; usually wider across posterior third than anterior third; midanterior margin rounded, often projecting beyond obtusely rounded anterolateral corners; lateral areas explanate (Fig. 2A,C,D,F,H,I) usually more widely so in posterior half; if viewed from above lateral margins usually divergent posteriorly at least in anterior half (Fig. 1); posterolateral corners rounded, usually obtusely.

Elytra. Punctation not larger than pronotal punctures; lacking deflexed apex; interstitial lines 1, 2 always moderately prominent; sutural and epipleural margins continuous to apex which is rounded.

Head. When viewed from above is either completely or partially covered in withdrawn condition by the pronotum (Figs 1, 2); vertex moderately to deeply depressed; posterolateral eye excavation present but not visible when head is retracted; GHW 6-13 × SIW; labrum small, not much broader than long, anterior margin curved; antennal sockets close, often contiguous, antennae never separated by more than 1.5 × ASW; frons-vertex junction often well defined and may be acute (Fig. 2C,F,G,I); eyes closely approaching ventrally. Mouthparts small, (Fig. 2), often feebly developed (Fig. 2I), apical segment of labial palpi fusiform or flattened and dentate along inner margin.

Antennae. Length slightly < GHW to slightly < 2× GHW; segments simple, usually 11, sometimes less, FS1 longer than pedicel; at least some FS not much longer than wide; apical FS never conspicuously shortened and club-like, no FS produced laterally or flattened.

Legs. All femora and tibiae straight, no femora or tibiae curved or swollen. MFC absent.

Abdomen. Posterior margin of basal abdominal sternites straight. Light organs occupying sternite 6 completely and entire in 7 although sometimes retracted to anterior half (Figs 3, 4); any slight retraction of the light organ material from the lateral margins is probably a post-mortem change. Sternite 7 MPP apically rounded, less than twice as long as wide, not upturned or engulfed by the downturned apex of tergite 8; posterolateral areas rounded but not produced; posterior margin lacking incurving lobes, pointed projections, median carina, median longitudinal trough and dimple; median posterior area not swollen or arched. Tergite 8 symmetrical, not conspicuously shortened, nor projecting conspicuously beyond the apex of the MPP of sternite 7, not downturned at its apex nor engulfing the apex of sternite 7; not heavily sclerotised; rounded posteriorly with median posterior margin gently emarginate and lateral margins subparallel; ventral surface lacking flanges, lateral troughs or elevated ridges; pale coloured.

Aedeagal sheath. (Fig. 21I,J) about 3 times longer than broad; anterior half of sternite moderately broad and symmetrical, posterior half asymmetrical; tergite lacking lateral protuberances and anterior margin evenly emarginate. Aedeagus length/width 1.8-3.5, symmetrical; ML not much longer than LL; LL separated by > half their length, lacking fleshy or strap like lobes at mid-point of their inner ventral surface; LL tapering to their apices and divergent at least in apical 1/6, and visible from below; basal piece lacking accessory appendages (Fig. 5).

FEMALE. Macropterous; or elytra fully developed with hind wings shortened or absent; or elytra about as long as pronotum, meeting in midline, and hind wings abbreviated; or elytra about half as long as pronotum, usually not contiguous in midline, and hind wings minute vestiges or absent (Fig. 6C).

Pronotum. Rounded anterior margin and usually subparallel-sided in brachelytral females (Fig. 6C); pronotal outline of macropterous females as for male (Fig. 6A,B).

Elytra. Interstitial lines present on all but very abbreviated elytra.

Head. Small, shallowly excavated between eyes, often concealed beneath pronotum when withdrawn in flightless females; GHW at least 2 × SIW in brachelytral females; eyes of macropterous females moderately reduced compared to male (Fig. 6B); eyes of brachelytral females considerably reduced (Fig. 6D,E).

Light Organ. Occupying sternite 6 only; sternite 8 tapering posteriorly (Fig. 6F-H).

LARVA. Tergal margins (except for terminal tergum) laterally explanate (Figs 7, 12, 15); tarsal claw 1/6 as long as tibiotarsus; all abdominal terga subequal in length and about half median length of thoracic tergum 3; otherwise as described for the genus *Luciola*.

REMARKS. Olliff (1890) described *Atyphella* from 3 new Australian species and included the first descriptions of an Australian lampyrid female and larva. Lea (1909) doubted the distinctiveness of *Atyphella* (based on the shape of the terminal abdominal segments in the male). Olivier (1909b) retained *Atyphella* because of its distinct 'facies' and restricted distribution. McDermott (1964) did not consider *Atyphella* a valid grouping and formally incorporated it into *Luciola* (1966). Ballantyne (1968) and Ballantyne & McLean (1970) treated *Atyphella* as a subgenus of *Luciola*; Ballantyne (in Calder, 1998) restored it to generic level based on 7 Australian species including *majuscula* (Lea) which was transferred from *Luciola*. The phylogenetic analysis performed subsequently supports an *Atyphella* clade and distinguishes 22 species, which are assigned here.

Olliff's (1890) incorrect assignment of *Atyphella* to the Lampyrinae because of the concealed head of the male, (while correctly assigning other Australian Lampyridae to the Luciolinae), may have led Lea and others to question its validity. Olivier's catalogues of 1902 and 1907 did not include *Atyphella*, which he first included, in the Luciolinae, in 1910.

Sixteen species were described originally as *Atyphella*, or reassigned subsequently. *Atyphella* is now considered to include the following 22 species including 6 new species, 7 non Australian species and 6 which were originally described as *Luciola* species.

Australian species: *atra* Lea; *brevis* Lea; *conspicua* sp. nov.; *costata* (Lea) gen. rev.; *ellioti* sp. nov.; *flammans* Olliff; *flammulans* sp. nov.; *immaculata* sp. nov.; *inconspicua* (Lea); *lewisi* sp. nov.; *lychnus* Olliff; *majuscula* (Lea); *olivieri* Lea; *scintillans* Olliff; *similis* sp. nov.

Non Australian species assigned here to *Atyphella*: *aphrogeneia* (Ballantyne); *carolinae* Olivier; *huonensis* (Ballantyne); *leucura* Olivier; *marginipennis* (Guérin); *obsoleta* Olivier; *wolfi* (Olivier).

The remaining 7 species originally assigned to *Atyphella* are not Australian and need further investigation. Four are not well represented in collections: *Luciola ignota* (Olivier) may simply be a pale variety of *A. obsoleta* Olivier; *L. messoria* (Olivier) and *L. scabra* (Olivier) are difficult to reliably identify in collections; *L. testaceolineata* (Pic) has an incomplete type and its similarities to the *flammans* – *flammulans* complex need to be investigated.

Ballantyne (1968) erected *Pygatyphella* as a subgenus of *Luciola*; it was distinguished by its distinctive abdominal modifications but named for its similarities to *Atyphella*. This study transfers to *Atyphella* two species of *Luciola* (*Pygatyphella*) (viz. *obsoleta* Olivier and *huonensis* Ballantyne) and all species of this subgenus should be investigated. Of the other species, *A. peculiaris* Olivier was assigned to *Luciola* subgenus *Pygatyphella* (Ballantyne, 1968). The position of *L. salomonis* Olivier is uncertain (Ballantyne, 1992).

Species groups in the following key are those identified by cladistic analysis and defined in Table 1.

KEY TO SPECIES OF *ATYPHELLA* MALES FROM AUSTRALIA

1. Pronotum yellow or cream with no darker markings . . . 2

Pronotum always with at least a median dark area on disc 4

2. Dorsal surface orange yellow except for black apical 1/5 of elytra . . . . *costata* (Lea)

Dorsal surface of pronotum yellow; elytra entirely black 3

3. Large (10.7-13.4mm long); elytra convex-sided when closed and bearing 4 well defined interstitial lines; lateral lobes of aedeagus closely approximate dorsally for most of their length (Fig. 5A-C) . . . *majuscula* (Lea)

Smaller (7-9mm long); elytra parallel-sided when closed, and bearing 3 well defined interstitial lines; lateral lobes of aedeagus divergent along their length dorsally (Fig. 5M-O) . . . . *immaculata* sp. nov.

4. Often very small (less than 4mm long); only 2 well defined interstitial lines (1, 2) present on elytra; if line 4 present it is ill defined and often effaced posteriorly . . 5

Never less than 6mm long; elytra always with at least 3 well defined interstitial lines 6

5. Pronotum cream with a median dark marking, pronotal margins always paler than rest; abdominal tergites 6 and 7 pale brown; light organs in sternite 7 appearing as 2 compact lateral areas closely adpressed to the sternite, with irregular less compact material between (Fig. 4H) . . . . *lewisi* sp. nov.

Pronotum moderately dark brown, margins not paler than rest; abdominal tergites 6 and 7 very dark brown, almost black; light organs in sternite 7 entire (Fig. 3C) . . . . *ellioti* sp. nov.

6. Elytra with 4 well defined interstitial lines of which line 3 is almost as long as lines 1, 2, or if shorter it is not effaced anteriorly 7

Elytra with at most 3 well defined interstitial lines present (1, 2, 4) of approximately equal length; if line 3 is present then it is not as well defined and is shorter than rest and effaced in front and behind 9

7. Elytra black, interstitial lines and margins not paler than rest . . . . *scintillans* Olliff

Elytra pale to moderately dark brown, margins and/or interstitial lines often paler than rest 8

8. Elytra dark brown with lateral, apical and sutural margins pale; interstitial lines 1-3 not paler than rest . . . . *olivieri* Lea

Elytra light to moderate brown; margins and interstitial lines usually slightly paler than rest . . . *lychnus* Olliff

9. Elytra moderate to dark brown, lateral margins and interstitial lines no paler than remainder 10

Elytra pale to dark brown, interstitial lines and sometimes also margins paler than rest 12

10. Pronotum sub-parallel-sided (Fig. 1E); head large, not completely concealed from above; mouthparts well developed . . . . *inconspicua* (Lea)

Lateral pronotal margins diverging posteriorly (e.g. Fig. 1A,F,J); head smaller, concealed from above; mouthparts not well developed 11

11. Elytra convex sided when closed; frons-vertex junction convex; antennal sockets not contiguous (Fig. 2A, B) . . . . *monteithi* sp. nov.

Elytra parallel-sided when closed; frons-vertex junction acute; antennal sockets contiguous (Fig. 2I) . . . . *atra* Lea

12. Medium to large (8-13mm long); elytra with 4 interstitial lines of which 3 is more faintly defined and always shorter than rest; all interstitial lines pale; frons-vertex junction ill defined, convex . . . . . . *flammans* Olliff

Smaller; elytra with at most 3 interstitial lines which may be paler than rest or not; frons-vertex junction well defined, acute 13

13. Antennal sockets not contiguous 14

Antennal sockets contiguous or very close 16

14. Frons-vertex junction with median area slightly elevated (Fig. 2F,G); antennal sockets separated by slightly greater than their width . . . . *conspicua* sp. nov.

Frons-vertex junction not elevated in median area; antennal sockets separated by ≤ their width (Fig. 2C) 15

15. Pronotum with lateral margins divergent at least in anterior half (Fig. 1I) . . . . *similis* sp. nov.

Pronotum with lateral margins subparallel (Fig. 1E) . . . . *inconspicua* (Lea)

16. Pronotum moderately dark brown, margins may be narrowly paler; mouthparts feebly developed; elytra either entirely medium brown with interstitial lines no paler than rest, or interstitial lines and lateral margins narrowly paler; elytra parallel sided when closed, only known from RF in SE Qld . . . . *atra* Lea

Pronotum cream with dark markings restricted to median area; mouthparts feebly to moderately developed; elytra never entirely medium brown, always with lateral margins and interstitial lines paler than rest; elytra slightly convex sided when closed; known only from RF in far NE Qld 17

17. Elytra pale, often semitransparent such that body outlines or hind wings may be visible through cuticle; frons 2-3 × ASW . . . . *brevis* Lea

Elytra not semitransparent, hind wings not visible, although fat body material beneath cuticle may be apparent; frons high, 5-6 × ASW . . . . *flammulans* sp. nov.

KEY TO KNOWN FEMALES OF AUSTRALIAN *ATYPHELLA*

1. Elytra and hind wings fully developed; elytra usually cover gravid abdomen and female assumed capable of flight 2

Female brachelytral; if elytra cover abdomen then hind wings are shortened or absent and female is flightless 3

2. Elytra uniformly dark brown . . . . . . *majuscula* (Lea)

Elytra orange yellow with black apices . . . *costata* (Lea)

3. Elytra either cover whole body or at most 2-3 abdominal segments visible beyond elytral apices 4

Elytra cover less than 1/3 of abdomen (Fig. 6C) 7

4. Elytra fully developed; hind wings shortened but always at least half as long as elytra 5

Elytra fully developed but may not cover gravid abdomen entirely; hind wings vestigial or absent 6

5. Hind wings almost as long as elytra; elytra dark brown with wide pale margins; interstitial lines no paler than rest . . . . *olivieri* Lea
Hind wings about 2/3 as long as elytra; elytra pale brown with margins and interstitial lines paler than rest . . . . *flammans* Olliff
6. Elytra with 4 well defined interstitial lines . . . . *lychnus* Olliff
Elytra with 3 well defined interstitial lines (1, 2 and 4) . . . . *atra* Lea
7. Elytra at least half as long as pronotum and contiguous in median line when abdomen is gravid . . . . *scintillans* Olliff
Elytra less than half as long as pronotum; sometimes contiguous in median line (Fig. 6C) 8
8. Elytra present as narrow lateral strips . . . *lewisi* sp. nov.
Elytra about as long as wide 9
9. Pronotum smooth, shiny, with punctures separated by 1-2 times their width; posterolateral corners of pronotum not projecting . . . . . *similis* sp. nov. & *conspicua* sp. nov.
Pronotum not markedly smooth or shiny, punctures contiguous; posterolateral corners of pronotum projecting (Fig. 6C) . . . . *inconspicua* (Lea)

KEY TO KNOWN LARVAE OF AUSTRALIAN *ATYPHELLA*

1. Protergum bearing tubercles (Fig. 15A, C) 2
Protergum lacking tubercles (Fig. 7A, Fig. 12, Fig. 15B) 3
2. Lateral margins of terga strongly ridged; punctures on anterior of terga 2-11 not large or conspicuous; dorsal colour pattern as in Fig. 15A . . . . *olivieri* Lea
Lateral margins of terga not strongly ridged; punctures on anterior of terga 2-11 large and conspicuous; dorsal colour pattern as in Fig. 15C . . . . . . *scintillans* Olliff
3. Posterolateral margins of protergum acute (Fig. 12C) . . . . *majuscula* (Lea)
Posterolateral margins of protergum rounded . . . 4
4. Terga 2-3 darker than remainder (Fig. 7A, Fig. 12A) . . 5
Terga 2-3 not darker than remainder (Fig. 12B, 15B) 6
5. Protergum dark brown with dark margins (Fig. 7A) . . . . *atra* Lea
Protergum pale with darker markings, margins pale (Fig. 12A) . . . . *flammans* Olliff
6. Dorsal colour moderately dark brown and yellow; no paler markings adjacent to median line in segments 2-9 (Fig. 15B) . . . . *lychnus* Olliff
Dorsal colour pale brown and cream (Fig. 12B); paler markings adjacent to midline on at least segments 2-7 . . . . *similis* sp. nov.

Atyphella atra Lea, 1921
(Figs 1, 2, 3, 7, 8)

Atyphella atra Lea, 1921a: 198. Ballantyne in Calder, 1998: 177 (comb. rev.).
Luciola (Luciola) atra (Lea). McDermott, 1966: 99.
Luciola (Atyphella) atra (Lea). Ballantyne & McLean, 1970: 281, figs 4a, b. Moore, 1989: 136.

TYPES. Holotype ♂, Australia, S Qld, 28.19S, 153.05E, Lamington NP (C2290, QM). Of 2♂ specimens on card, holotype indicated by 'TY'. Paratypes, 10♂ same locality as holotype, xi. 1920, HH, labelled as 'National Park, Queensland' (1 QM; 4 SAM; 1 MV; 2 BMNH; 2 ANIC).

MATERIAL. Holotype, 10 paratypes and 89 specimens. S QLD: 26.44S, 152.43E, Conondale, 29.xi.1974 (sites 12-13), GBM, 7♂ (UQ). 27.20S, 152.46E, Maiala NP, Mt. Glorious; 21.xi.1964, LP, 15♂, 6♀, 5 larvae, eggs (T. 91-93, 110-112, 154); 20.vi.1965, A. Jones, 1 larva (T.152). 6.30 p.m., 6.xi.1964, LP, 3♂ (T.95), 1♀ (T.94). Mt Glorious, nr Maiala NP, 1.xii.1966, GBM, S. Curtis, A. May, 37♂; x.1965, B. Ingram, 1 larva (T.153); 2♂ (QM). Lamington NP, xi. 1920, HH, 8♂ (QM, MV). NE NSW: 28.51S, 152.56E, Wiangaree SF, Antarctic Beach (sic), 13.xii.1986, V. R. Bejsak, 2♂, 1♀ (MM).

DIAGNOSIS. Male small to medium (5.4-7.0mm long); pronotum brown (margins may be paler); elytra light brown often with the 3 interstitial lines (1, 2, 4) and lateral margins slightly paler; elytra parallel-sided when closed; antennal sockets contiguous; mouthparts small, non functional; frons-vertex junction acute (Fig. 2I). Female dingy cream; elytra fully developed, hind wings vestigial. Larva (Fig. 7A) with dark brown thoracic terga having few paler markings; abdominal terga cream with scattered dark markings.

DESCRIPTION. Males are redescribed; females and larvae are newly described.

Male. 5.4-7.0mm long (holotype 7.0mm long): pronotum dusky brown, sometimes with anterior and lateral margins narrowly paler, and darker brown markings anteriorly on disc; pronotal punctures often narrowly ringed with brown or black; MS cream or dingy cream, sometimes brown in posterior half; MN dingy cream; elytra shiny, light - moderately brown, three interstitial lines and lateral margins sometimes paler; head and antennae very dark brown; ventral surface of pro and mesothorax light brown, of metathorax dark brown; legs pale brown, femora sometimes paler than rest; ventral abdomen black except for white sternites 6, 7; dorsal abdomen dark brown except for pale cream tergites 7 & 8.

Pronotum (Fig. 1A) 1.7-2.5mm wide; 0.9-1.4mm long, W/L (holotype) 2.0; midanterior margin broadly rounded or straight, and produced a little, if at all, beyond anterolateral angles; anterior margin sometimes reflexed; lateral margins diverging posteriorly; median posterior margin indented or not; disc fairly flat, irregularly depressed, posterolateral ridge pronounced; punctures broad, shallow, contiguous, not all the same size. Elytra parallel sided, with 3 interstitial lines (1, 2, 4) of which 1 & 2 are well defined.

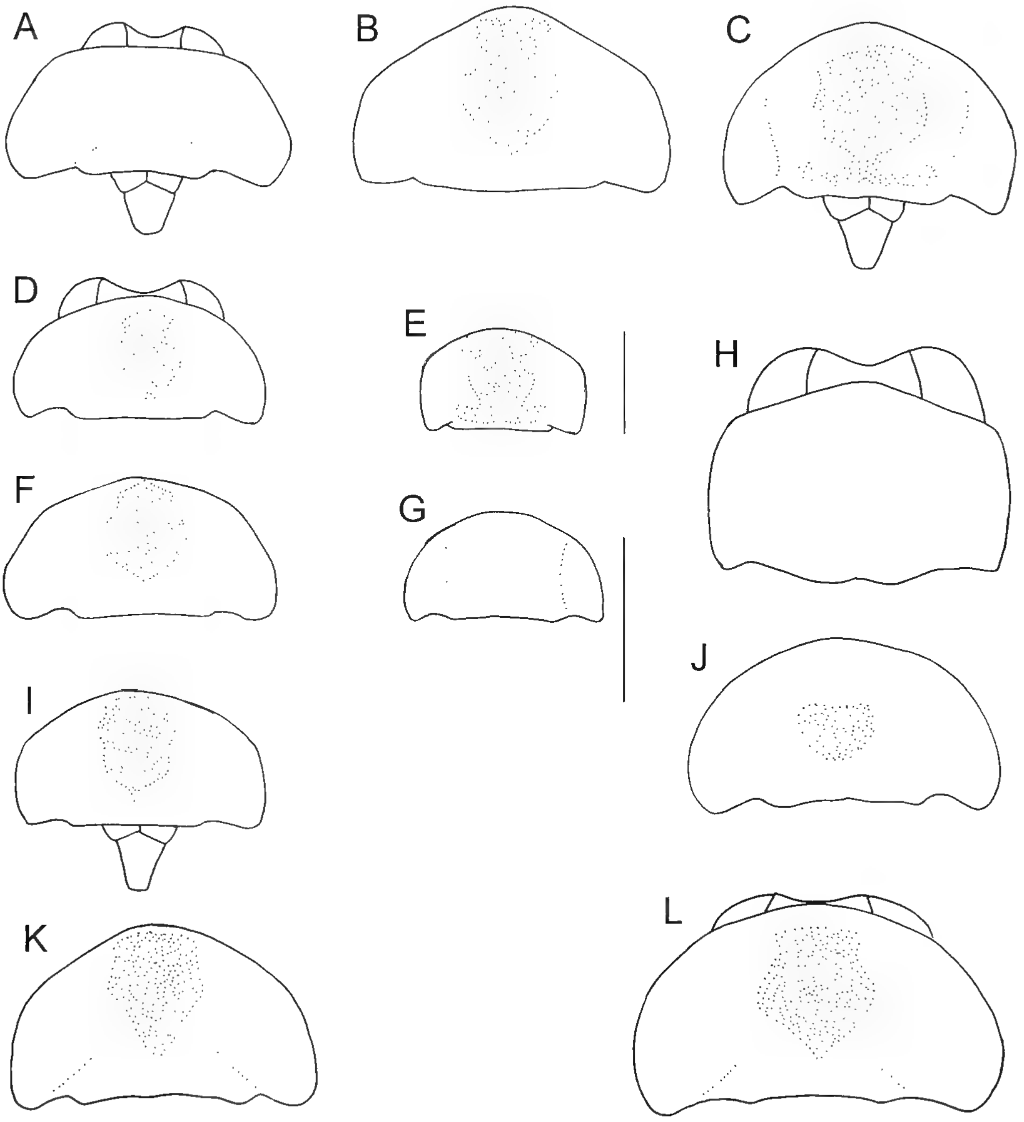


FIG. 1. Dorsal views of pronota of ♂ *Atyphella*; stippling indicates extent of colour pattern; A, D, H, L, show exposed head. A, *Atyphella atra* holotype; B, *A. conspicua*; C, *A. scintillans*; D, *A. brevis*; E, *A. inconspicua*; F, *A. olivieri*; G, *A. ellioti*; H, *A. costata*; I, *A. similis*; J, *A. monteithi*; K, *A. flammulans*; L, *A. flammans*. Scale lines 1mm; all but G share upper scale.

Head (Fig. 1A, 2I) almost concealed beneath pronotum at rest; deeply depressed between eyes; GHW 0.8-1.3mm; SIW 0.1mm; antennal sockets contiguous; frons high and flat, about 2 × ASW, frons-vertex junction acutely margined; mouthpart complex very small, non functional; apical segment of labial palpi fusiform. Antennal length subequal to GHW; antennal FS 1 acutely narrowed basally, 1.5 × as long as FS 2; FS 2-8 subequal, half length of FS 1, about as long as broad; FS 9 slender, longer than FS 8.

Light organs occupying sternites 6 & 7 entirely except sometimes for a narrow posterior margin of 7; (Fig. 3A); MPP of sternite 7 moderately

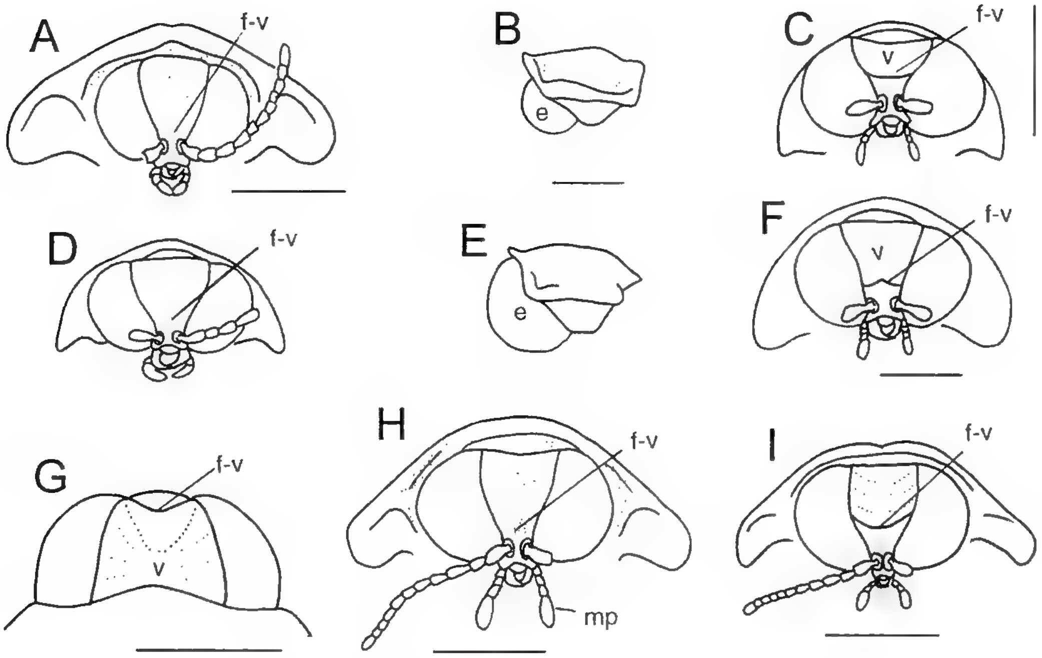


FIG. 2. Head and pronota, ♂ *Atyphella*; anterior aspects show part or all of one antenna only; lateral aspects show pronotum and extent of eye only. A, B, *A. monteithi*; C, *A. inconspicua*; D, E, *A. costata*; F, G, *A. conspicua*; H, *A. olivieri*; I, *A. atra*. Scale lines 1mm; lines shared by: B-E. e = eye; f-v = frons vertex junction, mp = maxillary palp, v = vertex.

produced and apically rounded; tergite 8 with lateral margins subparallel and median posterior margin gently produced. Aedeagus L/W 2.3; basal piece not hood like; ML slightly expanded around EO; not bulbous at apex, and not produced dorsally; LL narrowing slightly in apical 1/3, and divergent along their length in median line; hairs along lateral margins of LL in apical 1/3.

Female. 4.3-6.0mm long; with fully developed elytra, hind wings represented by minute vestiges. Dorsal body may be entirely pale cream or pale brown with no darker markings; or pronotum with median brown markings, MN dark margined and basal third of elytra slightly darker than rest; head cream - pale brown, eyes red - brown; antennae uniformly brown, or basal segments dark brown, and apical segments pale; legs brown, hind coxae dark brown; ventral surface of thorax dingy cream; abdomen pale cream; ventral surface may be orange yellow in older specimens.

Pronotal outline like male but midanterior margin indented and projecting anteriorly beyond rounded anterolateral angles; punctures broad, shallow, contiguous in lateral areas of disc, separated puncture width in middle of disc. Elytra convex-sided when closed, with 3 well-defined interstitial lines (1, 3 and 4). Head form of wingless female head type (Fig. 6E). Last 2 segments of abdomen of gravid female protrude beyond end of elytra; light organ may be retracted from all margins in sternite 7; posterior margin of sternite 8 broadly and shallowly emarginate, sternite 9 narrowing posteriorly and median posterior margin entire or slightly emarginate.

Larva. (Fig. 7A). Lateral margins of terga 1-11 covered in fine short hairs and spines, not conspicuously ridged; median line on terga 1-11 not laterally ridged; punctures in anterior half of terga 2-10 not obviously larger than rest. Protergum 1.2-1.4mm long; 1.7-2.3mm wide; median anterior area of protergum narrowing slightly; median anterior margin of protergum indented, lacking tubercles. Posterolateral corners of thoracic and abdominal terga rounded; posterolateral corners of terminal abdominal tergum not produced. Head elongate slender,

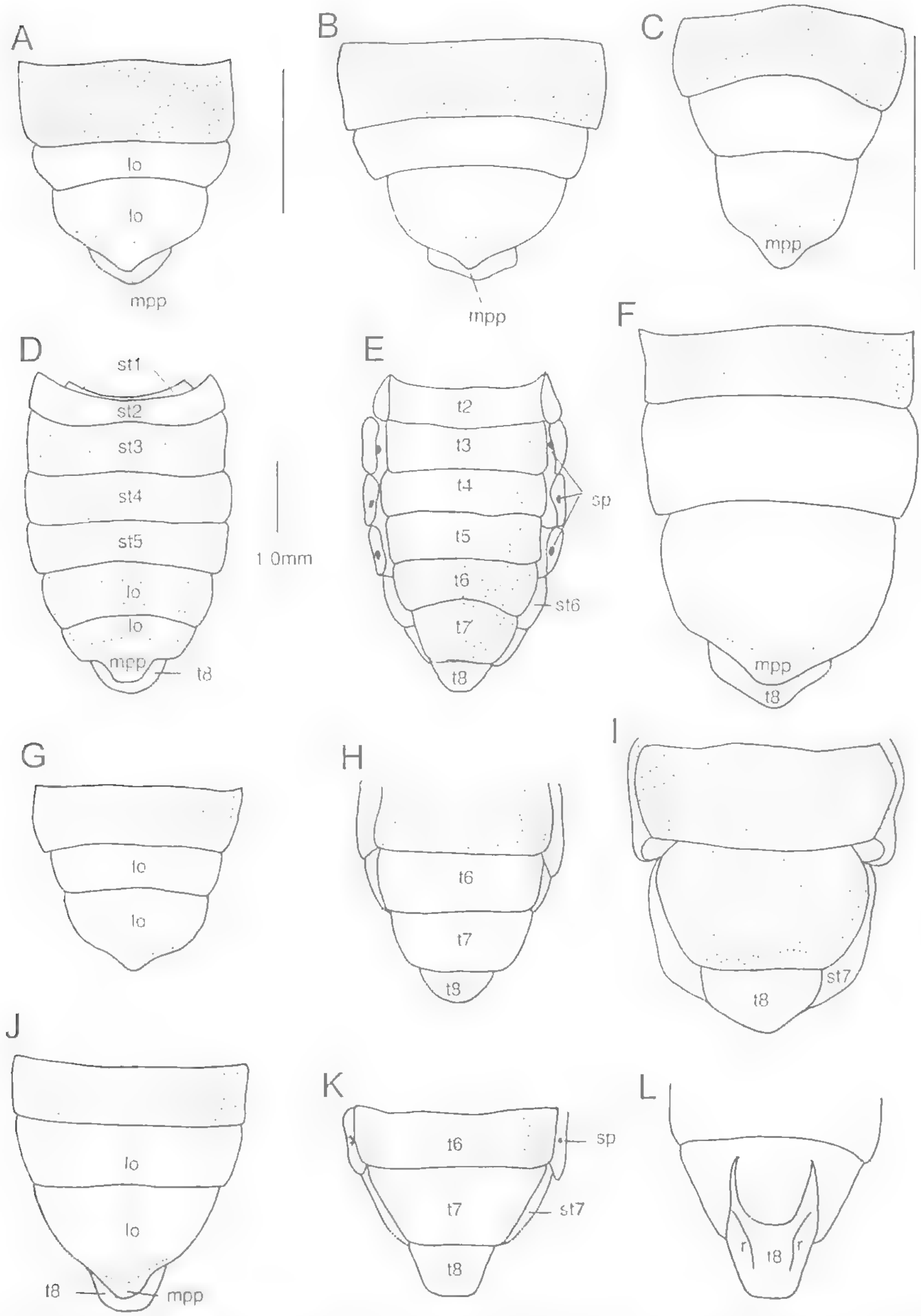


FIG. 3. Terminal abdomen, ♂ *Atyphella*; A-D, F-H, J-L, ventral aspect of abdominal sternites; E, I, K, dorsal aspect of abdominal tergites; L, ventral aspect of abdominal tergites. A, *A. atra*; B, *A. brevis*; C, *A elliotî*; D,E, *A. costata;* F, I, *A. olivieri*; G, H, *A. inconspicua*; J-L, *A. majuscula*. Scale lines 1mm; lines shared by: A, B & F-I; D, E & J-L. lo = light organ; mpp = median posterior projection sternite 7; sp = spiracle; st1-7 = sternites 1-7; t2-8 = tergites 2-8; r = ridge.

twice as long as wide; median anterior margin broadly emarginate.

Thoracic terga dark brown, with a median posterior pale area on terga 1-3; protergum with paired anterior, lateral and posterolateral pale markings; mesotergum and metatergum with paired lateral and midposterolateral pale areas; metatergum with irregular cream areas along anterior margin to each side of midline. Abdominal terga 4-9 dingy cream, with midlateral brown markings being more pronounced on terga 7-9; terga 10, 11 cream, 12 dark brown. Ventral surface of lateral expansions of thoracic plates dark brown with median cream areas; legs uniformly brown; median thoracic sternal plates scarcely differentiated; ventral surface of lateral expansions of terga on abdominal segments 4-9 pale; ventral surface of abdominal segments 4,5 including sternum and epipleural plates marked extensively in brown; ventral surface of abdominal segments 6-8 mainly cream with some brown markings; epipleural plates of segment 9 mostly dark brown; segments 10-12 cream with scarce dark markings.

DISTRIBUTION. Known from three disjunct mountain rainforest systems: the Lamington Plateau (including Wiangaree) on the Qld/NSW border, and the D'Aguilar and Conondale Ranges, respectively 40 and 90km NNW of Brisbane (Fig. 8).

REMARKS. Lea (1921a) considered this species 'close to *Atyphella brevis* and *A. olivieri*', and recorded the colour as black; neither the type specimen nor more recently collected males have such a dark dorsal colouration.

One of the females taken at Maiala NP in November 1964 (in UQ) deposited eggs. The elytra were parted, the abdomen curved dorsally, and the individual egg held for some time between the styli before being deposited. These eggs are 0.5-0.6mm across, round, cream, soft, unsculptured. Luminosity was not observed. This species and *A. lychnus* were taken together at the Conondale site.

Atyphella brevis Lea, 1909

(Figs 1, 3, 9)

Atyphella brevis Lea, 1909: 111, fig. 103; 1921a: 197; 1929: 345. Olivier, 1910: 46. Tillyard, 1926: 212, fig. R43. Ballantyne in Calder, 1998: 177 (comb. rev).
Luciola (Luciola) brevis (Lea) McDermott, 1966: 100.

TYPES. Lectotype.♂ Australia, N Qld: 17.16S, 145.29E, Atherton, (SAM). Of three♂ syntypes glued onto card the lectotype is indicated with 'TY; labels are: 1. *brevis* (handwritten), Lea Type (printed), Atherton (handwritten), 2. Handwritten label, '*Atyphella brevis* 8729 Lea Queensland' with 'type' handwritten in red at end of label. Paralectotypes. 2♂ on same card as lectotype. These 3 specimens are all that remain of the original 12 syntype series.

MATERIAL. Lectotype, 2 paralectotypes, and 146 specimens. N QLD: 5♂, H. Peters, 2♂, A. Feynes (CAS); 12♂ (QM); 2♂ E. Ferguson (ANIC). 15.43S, 145.17E, Big Tableland, NE cnr, 800m, ANZSES exp., 20.xii.1990-8.i.1991, FIT and PF traps, 1♂ (QM). 15.52S, 145.14E, Mt Misery summit, 850m, Qld Mus & ANZSES FIT site 3, 6.xii.1990-17.i.1991, 2 ♂. 15.57S, 145.08E, Mt Boolbun Sth, 850-1000m, 4-6.xi.1995, GBM, 10♂ 16.03S, 145.23E, Mt Halcyon, 870m, 22-24.xi.1993, GBM, 7♂ 16.04S, 145.25E, Roaring Meg Valley, 680m, GBM, 7♂ 20-22.xi.1993, 2♂ 7-9.xii.1993. 16.06S, 145.20E, McDowell Ra. 17km N of Daintree, 27.xi.1985, in RF, sieved litter at 520m, QM berlesate 684, 2♂. 16.30S, 145.19E, Mt Demi summit, 1100m, FIT, 17.xii.1996-25.i.1996, GBM et al., 1♂. 16.49S, 145.38E, Kuranda, G. Bryant, 13.xi.1909, 1♂. (BPBM). Mt Formantines, 10km N of Kuranda, 700m, 23-24.xi.1990, GBM et al., 12♂ (QM). 16.55S, 145.46E, Cairns, E. Allen, 1♂; J. Anderson, 2♂. 17.02S, 145.37E, Davies Ck, (15 road km from Kennedy Hwy, 21km E by S of Mareeba), 1.iii.1988, D. Rentz, stop A-28, 28♂ (ANIC). 17.03S, 145.41E. Upper Isley Ck, 750m, 29-30.xi.1993, Cook et al., 3♂ (QM). 17.06S, 145.36E, Mt Haig, 1150m, 1.xii.1994-3.i.1995, PZ, 6♂ malaise trap; 4 ♂ FIT ANIC; 2 males FIT JCU (west); 1♂ FIT JCU (east) (ANIC). 17.12S, 145.51E, Bellenden Ker Ra., Cable Tower 3, 1054 m, 17.x-5.xi.1981, Earthwatch/Q Museum. malaise trap, RF, 1♂ (ANIC Voucher 83-0670). 17.16S, 145.29E, Atherton, 7.i.1966, P. Twine, 1♂ (UQ); 4♂ (MV); 1♂ (AM). Ringrose NP via Atherton, 9.xii.1966, BC, 1♂ (T.218 UQ). Lake Barrine, Deane, 4♂. 17.23S, 145.23E, The Crater, nr Herberton, xii.1961, DKM, 2♂ (AM). 17.28S, 145.29E, Longlands Gap, BS1, 1150m, 1.xii.1994-3.i.1995, PZ, FIT, 2♂ (ANIC). 17.31S, 145.37E, Millaa Millaa Falls, 9.i.1964, 1♂ (UQ). 17.36S, 145.45E, Henrietta Ck, Palmerston NP, GBM, 20♂, 29.xi.1964, 3♂ 23.iv. 1970; 4♂29.xii.1964 (T.130), 6.xii.1965 7♂ (T.186); 12.xii.1966, BC, 1♂ (T.216); 2♂ (QM). 17.37S,145.34E, Massey Ck, 1000m, BS3, 1.xii.1994-3.i.1995, PZ, FIT, 1♂ (ANIC). Tully Falls SF, 9.5km SSW of Ravenshoe, 9.ii-3.iii.1988, RS & Dickinson, MDPI FIT 29/4, 3♂ (DPI).

DIAGNOSIS. Male small to medium (5.5-7.0mm long); pronotum cream with median dark marking; elytra slightly convex sided when closed, light to medium brown, with suture, lateral margin and the 3 interstitial lines paler; elytra semitransparent with hind wings usually visible beneath; antennal sockets contiguous or nearly so; mouthparts poorly developed; frons-vertex junction acutely margined. Female and larva not associated.

DESCRIPTION. *Male*. 5.5-7.0mm long (lectotype 5.9); pronotum cream with median dark brown markings (Fig. 1D); MS usually cream, sometimes dingy brown, MN cream; elytra semitransparent such that hind wings are often visible beneath cuticle; elytra pale to medium brown with interstitial lines cream, and all margins except for base narrowly cream; a faint pale line may exist in the position of interstitial line 2; elytra sometimes very pale, scarcely any darker than interstitial lines; head very dark brown, antennae lighter brown; ventral thorax cream except for dark brown metathorax, hind coxae, and tibiae and tarsi of all legs; ventral abdomen dark brown except for pale cream sternites 6 & 7; dorsal abdomen dark brown except for pale tergites 7 & 8.

Pronotum (Fig. 1D) 1.9-2.3mm wide; 1-1.2mm long; W/L (lectotype) 1.8; midanterior margin bluntly rounded, usually produced beyond anterolateral angles; lateral margins slightly divergent posteriorly; punctures close, but not all contiguous. Elytra slightly convex sided when closed, with 3 well defined interstitial lines (1, 2, 4) and sometimes traces of line 3, which is feebly developed, effaced in front and behind and not margined by punctures.

Head almost concealed beneath pronotum at rest; deeply depressed between the eyes; GHW 1.2-1.6mm; SIW 0.1-0.2mm; ASD < ASW, sockets contiguous or nearly so; frons high, at least 2 × ASW, frons-vertex junction acutely margined; mouthparts small; apical segment of labial palpi entire. Antennal length subequal to GHW; FS 1 narrowed basally, slightly longer than 2, which is slightly longer than 3; FS 4-8 subequal, about as long as wide.

Light organs (Fig. 3B) occupying sternites 6 & 7 except for narrow to moderately wide band across posterior margin of 7; MPP of sternite 7 moderately produced and apically rounded; lateral margins of tergite 8 subparallel; mid-posterior margin rounded and projecting beyond rounded posterolateral corners. Aedeagus L/W 2.3; basal piece not conspicuous and hood-like; ML slightly bulbous at apex and at the level of the EO, not projecting dorsally; LL subparallel-sided, broad at apex, very close in dorsal aspect, and separating only in apical 1/3: hairs along lateral margins of LL in apical 1/3.

DISTRIBUTION. Widespread in mountain rainforest of the Wet Tropics zone of N Qld from just south of Cooktown to a little south of Ravenshoe. Altitude records range from 400-1160m, with the exception of an early record from sea level at Cairns which is probably inaccurate (Fig 9).

REMARKS. Lea (1909) recorded this species as close to some *A. lychnus* but he may have confused some specimens. He considered that *A. brevis* and *Luciola cowleyi* 'might fairly be regarded as linking *Atyphella* and *Luciola* together'. There is only a superficial colour similarity (Ballantyne, 1968) between these very different species. Lea (1921a) considered that the female of *brevis* was unknown, but indicated at least one Queensland species (not named) had larva-like females; subsequently Lea (1929) recorded 2 males of *A. brevis* and 2 larva-like forms, 'possibly females' of *brevis* (from Lamington NP, in QM). The males are *Atyphella similis* sp. nov. and the larvae *A. scintillans*. E. Allen's personal copy of Lea's 1909 paper, from the Entomological Society of Queensland library, has a pencilled notation by Allen on page 111, against the description of *brevis*: 'discovered later in my excursions that the females are wingless and remained on the ground where the males found them'. I have not been able to associate females with this species.

Tillyard (1926: 212, fig. R43) inaccurately shows *A. brevis* male with 3 instead of 2 sternites containing the light organ.

Atyphella conspicua Ballantyne sp. nov.

(Figs 1, 2, 10)

TYPE. Holotype.♂, 16.42S, 145.13E, Stewart Ck, 4km NNE Mt Spurgeon, camp 2, 1200-1250m, 17-19.x.1991, GBM, HJ, DC & Roberts (QMT61017, QM).

MATERIAL. Holotype and 94 paratypes. N QLD: 15.42S, 145.13E, Mt Finnigan summit via Helenvale, 28-30.xi.1985, 1100m, PF traps, RF, GBM, DC, 2♂; Mt Finnigan, 760m, 20-27.vii.1974, GBM, DC, 1♂ (QM). 16.10S, 145.23E, Thornton Peak via Daintree, 1000-1300m, 20-22.ix.1981, GBM, DC, 4♀. 16.28S, 145.23E, nr plane crash site 11km NW of Mossman, 27.xii.1989, 1240m, ANZSES, 2♂. Carbine Tbld, plane crash site, 27-28.xi.1990, 1330m, PF traps and hand. GBM, 22♂. Carbine Tbld, above Fern Patch, Devil's Thumb, 26-27.xi.1990, 1050m, PF traps, GBM, HJ, 3♂. 16.34S, 145.16E, Mt Lewis via Julatten: 2.5km N of, 3.xi.1983, DY, GT, berlesate 613, RF, sieved litter, 1♂ 26.xi.1980, RS & Titmarsh, berlesate, 1♂ (DPI); top of Mt Lewis, 27.xi.1965, GBM, 2♂ (taken with one♂ of *A. inconspicua*; T.189, UQ). 16.42S, 145.13E, Stewart Ck, 4km NNE Mt Spurgeon, camp 1, 1250-1300m, 15-20.x.1991, GBM, 18♂; camp 2, 1200-1250m, 17-19.x.1991, 30♂, 4♀ (QM). 17.36S, 145.45E, Henrietta Ck, 6.xii.1965, GBM, 2♂ (taken with 2♂ of *A. inconspicua*).

DIAGNOSIS. Males distinguished from *A. inconspicua* by the divergent lateral margins of the pronotum, the median elevation of the frons-vertex junction and relatively larger size

(7.2-9.8mm long); distinguished from *A. similis* by the shape of the frons-vertex junction, colour of terminal abdominal tergites, and its northerly distribution. Possible female brachelytral.

DESCRIPTION. *Male.* 7.2-9.8mm long; pronotum may be light brown or pale cream with median area darker brown; MS and MN pale cream; elytra light to quite dark brown, interstitial lines 3 and 4 sometimes paler brown; head between eyes very dark brown, sometimes paler brown below antennal insertions; labrum pale brown; antennae and palpi brown; ventral pro- and mesothorax and bases of legs pale yellow, apex of femora, tibiae and tarsi brown; ventral metathorax light brown; basal abdominal sternites very dark brown; light organs white; basal abdominal tergites brown, tergites 7 and 8 pale cream, posterior margin of 7 may be narrowly brown.

Pronotum (Fig. 1B) 1.6-2.8mm wide, 1.4-1.6mm long, W/L 1.7 (holotype); midanterior margin rounded and considerably produced beyond rounded anterolateral angles; lateral margins divergent posteriorly in at least anterior 2/3, often convergent in posterior 1/3 or less; punctures broad, shallow, contiguous over most of dorsal surface except in median area where punctures are smaller and small shiny apunctate areas exist. Elytra parallel-sided, with 3 interstitial lines of which 1, 2 are best defined.

Head partially concealed at rest; moderately deeply excavated between eyes; GHW 1.7-2.1mm; SIW 0.3mm; ASD subequal to or slightly > ASW; frons with transverse depression above antennal insertions and often a median longitudinal depression; frons height subequal to ASW, frons-vertex junction acutely margined and elevated in median line (elevation visible from in front, or above, or from both aspects Fig. 2F,G); mouthpart complex well developed; apical segment of labial palpi fusiform. Antennal length subequal to or slightly longer than GHW; FS 1 slightly longer and narrower than FS2; FS2 as wide as, but slightly longer than FS3; FS 4-8 subequal in length, and slightly shorter than FS3; FS9 about 1.5 times as long as FS8.

Light organs occupying sternites 6 and 7 entirely except for posterior margin of sternite 7 and sometimes also narrow lateral margins; MPP of sternite 7 moderately produced and apically rounded; tergite 8 with lateral margins subparallel and median posterior margin rounded. Aedeagus as described for *A. inconspicua*.

Female. Associated by similarity of label data only; about 8mm long (females examined are gravid and very soft); brachelytral, hind wings represented by minute vestiges. Dorsal body pale cream, semitransparent; pronotum with pale brown median marking and elytra light brown with pale interstitial lines, suture and lateral margin; light organ in sternite 7 paler than rest.

Pronotum with median anterior margin indented; anterolateral angles not distinguishable from above; lateral margins slightly divergent posteriorly along their length; posterolateral corners of pronotum not projecting; dorsal surface very smooth and shiny, punctures small, shallow, separated by 1-2 × their width. Elytra on alcohol-preserved specimens can be manipulated with forceps to touch in the median line but are not contiguous in any of the 4 females examined; with 3 well-defined interstitial lines. Head covered by pronotum at rest, of form of wingless female head type. Median posterior margin of sternite 8 broadly emarginate, of sternite 9 entire.

DISTRIBUTION. Restricted to the Wet Tropics of N Qld where all records are from high elevation (750-1300m) in mountain blocks 1, 2 and 4 except for one collection at 350m in block 14; usually the only species taken, except twice with *A. inconspicua* (Fig. 10).

REMARKS. *A. conspicua* is named for its similarity to *A. inconspicua* and its distinguishing features of larger size and more conspicuous 'facies'.

Atyphella costata (Lea) comb. nov.
(Figs 1, 2, 3, 5, 6, 8)

Luciola costata Lea, 1921b: 66.
Luciola (Luciola) costata Lea. McDermott, 1966: 102. Calder, 1998: 178.

TYPES. Holotype.♂, Australia, Northern Territory: 14.44S 131.08E, Flora River, ix. 1912, Spencer (T2876, MV). Paratype♂ same data (I12280, SAM).

MATERIAL. Holotype, 1 paratype and 62 specimens. 10.00S, 142.00E, Moa (Banks) I., at light, W. McLennan, 2♂ 17.i.1920 (SAM); 11.i.1920 8♂ (AM). NORTHERN TERRITORY: 13.49S, 136.28E, Groote Eylandt, N. Tindale, 5♂ (SAM), 2♂ (AM). 12.27S, 130.50E, Tortilla Flats via Darwin, 8.xii.1966, C. Li, 2♂ (MAGNT). 14.11S, 132.11E, Edith Falls, xii.1983, Potts, 1♂. 14.23S, 129.51E, Beebom Crossing, Daly R on Tipperary Station, 28.xi.1972, T Angeles & N Forrester, 3♂. 14.28S, 132.16E, Katherine, Maud Ck, 3.xii.1978, RS, at light, 2♂ (DPI). Katherine, 28.ii.1973, T.W. & A. Allwood, 1♂. 14.29S, 131.22E, Crocodile R nr Dorisvale, MV light, 17-18.xi.1984, M. Malipatil, 11♂. 14.30S, 132.15E, 3km

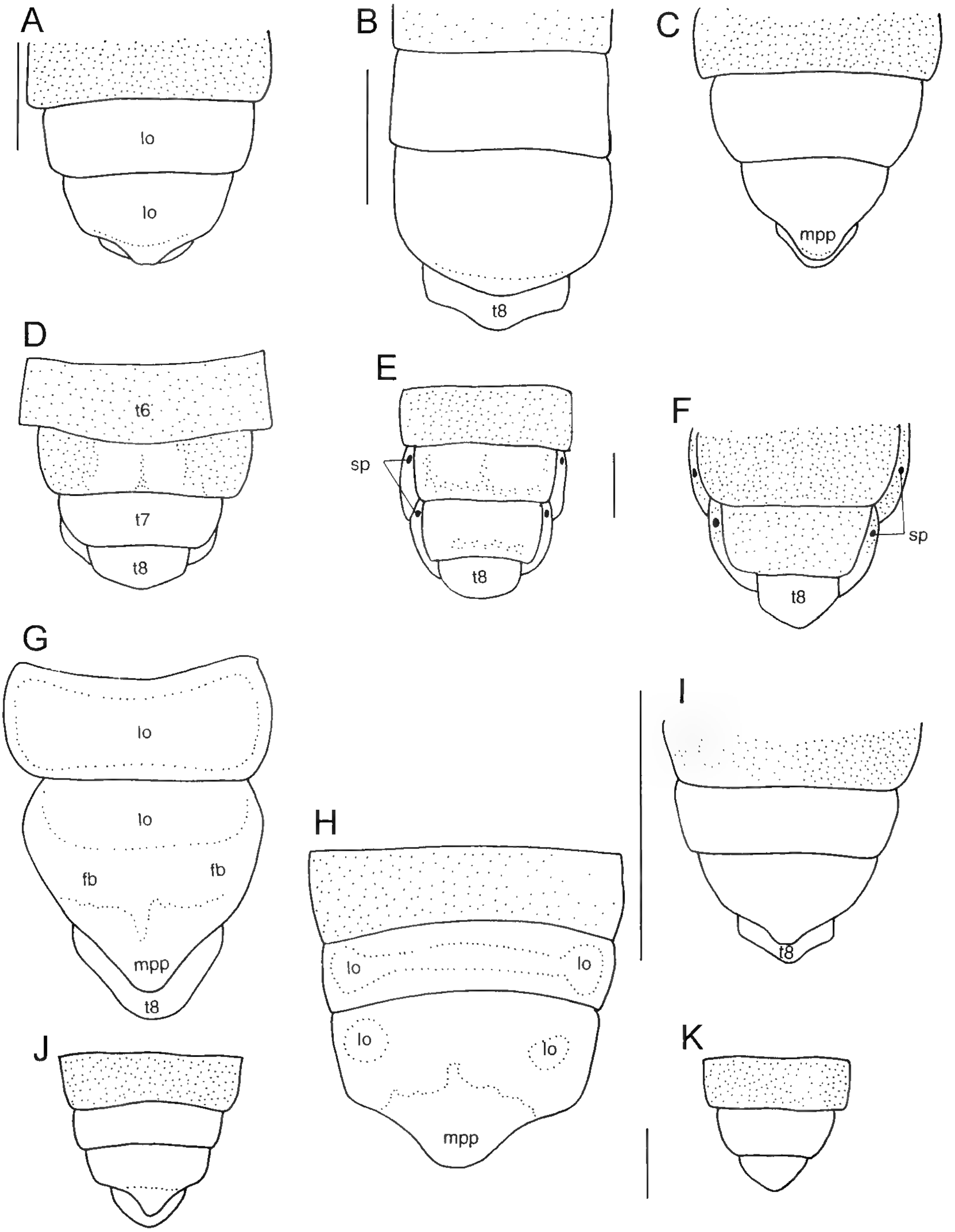


FIG. 4. Terminal abdomen, ♂ *Atyphella*; A-C, G-J, ventral aspect of abdominal sternites; D-F, K, dorsal aspect of abdominal tergites. A, D, *A. similis*; B, E, *A. immaculata*; C, F, *A. monteithi*; G, *A. flammulans*; H, *A. lewisi*; I, *A. lychnus*; J, K, *A flammans*. Scale lines 1mm; lines shared by: A, C, D, F; B, G, I; E, J, K. Abbreviations as for Fig. 3.

SSW of Katherine, 12.xi.1979, TW, 4♂ (ANIC). Katherine Gorge NP, 4-5.xii.1980, M. Malipatil, 1♂ (MAGNT). 14.31S, 132.22E, Tindal, 1-20.xii.1967, light trap, W. Vestjens, 2♂ (ANIC). 14.39S, 133.06E, Mataranka, 1.iii.1967, MU, 1♂. 14.44 S 131.08E, Flora R, ix.1912, Spencer, 3♂ (MV). 14.56S, 133.04E, Roper R crossing 2km W of Mataranka Hsd, 11.i.1992, M. & B. Moulds, 6♂ (AM). 14.57S, 133.13E, Roper R, N. B. Tindale, 1♂ (MV). 15.40S, 130.39E, Victoria R Depot, 4♂ (BMNH). N QLD: 13.01S, 141.47E, 40km S of Weipa, 1-10.xii.1987, Clarkson, DeCampo, 1♂ (DPI). 13.05S, 142.56E, Wenlock R, 12.xii.1986, M.V. lamp, G. Daniels, M. Schneider, 1♀ (UQ).

DIAGNOSIS. Male 7.7-9.7mm; one of only two Australian fireflies which are dorsally yellow with apical black patches on elytra; distinguished from *Luciola dejeani* by the dark brown abdominal sternites 4 and 5, the well developed elytral interstitial lines, and the form of the aedeagus. Female macropterous, coloured as for male except for pale terminal abdomen. Larva not associated.

DESCRIPTION. Males are redescribed; females are newly described.

Male. 7.7-9.7mm long (holotype 8.7mm long); dorsal surface yellow to orange yellow, except for apical black area on elytra; head between eyes, antennae, and palpi dark brown; ventral thorax yellow except for dark brown tibiae and tarsi of all legs; abdominal sternite 2 yellow, 3-4 yellow with lateral brown markings or 3-4 entirely dark brown; 5 dark brown, 6 and 7 creamy white; abdominal tergites brown (6 and 7 may be darker brown than preceding tergites), tergite 8 paler brown than remainder.

Pronotum (Fig. 1H) 2.5-3.2mm wide, 1.7-2.1mm long; W/L 1.5 (holotype); midanterior margin rounded, moderately produced beyond conspicuous but rounded anterolateral angles; lateral margins subparallel or slightly divergent posteriorly; median posterior margin gently indented; punctures broad, shallow, contiguous except over median area of disc. Elytra parallel-sided when closed, with interstitial lines 1, 2 well-defined, 3, 4 faint.

Head (Figs 1H, 2D,E) not completely covered by pronotum at rest, moderately excavated between eyes; GHW 1.9-2.4mm; SIW 0.2-0.4mm; ASD slightly < ASW; frons 1 × ASW, frons-vertex junction not clearly defined and rounded; mouthparts well developed; apical segment of labial palpi flattened and dentate. Antennal length > GHW but < 2 × GHW; FS 1 slightly longer than subequal FS 2, 3; FS 4-9 subequal, a little shorter than FS 2, 3.

Light organs (Fig. 3D) either occupying sternites 6 and 7 completely or retracted to basal half or less of sternite 7 (such retraction may be a post-mortem change); MPP broad and apically rounded, lateral margins convergent posteriorly; posterolateral 'corners' of sternite 7 apparent and angulate on certain pinned specimens, angles obliterated after short period of soaking in water/detergent mixture; tergite 8 rounded posteriorly (Fig. 3E). Aedeagus L/W 2-3, like that of *Atyphella majuscula* (Fig. 5G-I) but lacking the hood like basal piece; ML scarcely expanded at apex or around EO; LL subparallel sided or margins tapering slightly posteriorly; LL broad in lateral aspect and closely approximate for most of their dorsal length and diverging only at their apices; LL bear a small subapical hook, and hairs are restricted to lateral margins in apical 1/3.

Female. (Fig. 6A,B); 9mm long; macropterous and known to be capable of flight; coloured as for male except for pale light organ in sternite 7, and yellow sternites 8, 9.

Pronotal outline and punctures, and form of elytra, as for male. Head form of winged female head type (Fig. 6B), not conspicuously smaller than that of male, GHW 11 × SIW; ASD > ASW; vertex shallowly excavated. Abdomen not protruding beyond elytral apices; median posterior margin of sternite 8 shallowly and broadly emarginate; sternite 9 tapering posteriorly, median posterior margin entire.

Larva. Unknown.

DISTRIBUTION. Gulf of Carpentaria islands, Northern Territory near rivers, far N Qld (Fig. 8).

REMARKS. Lea (1921b) emphasised its distinctiveness from the only other similarly coloured Australian species, *Luciola dejeani*. Both these pale species conform in colour pattern to *Lampyris incerta* Boisduval, described from New Holland, (listed here as *Species Incertae*). McDermott (1966) listed 40 Indomalaysian Luciolini with this dorsal colour pattern. The single female was taken when many other flashing specimens were observed flying (M. Schneider, pers. comm.).

Atyphella ellioti Ballantyne sp. nov.
(Figs 1, 3)

TYPE. Holotype.♂, Australia, N Qld: 19.16S, 146.49E, Mt Elliot NP, Upper North Ck, 1000m, 2-5.xii.1986, RF, GBM, GT, SH (QMT61104).

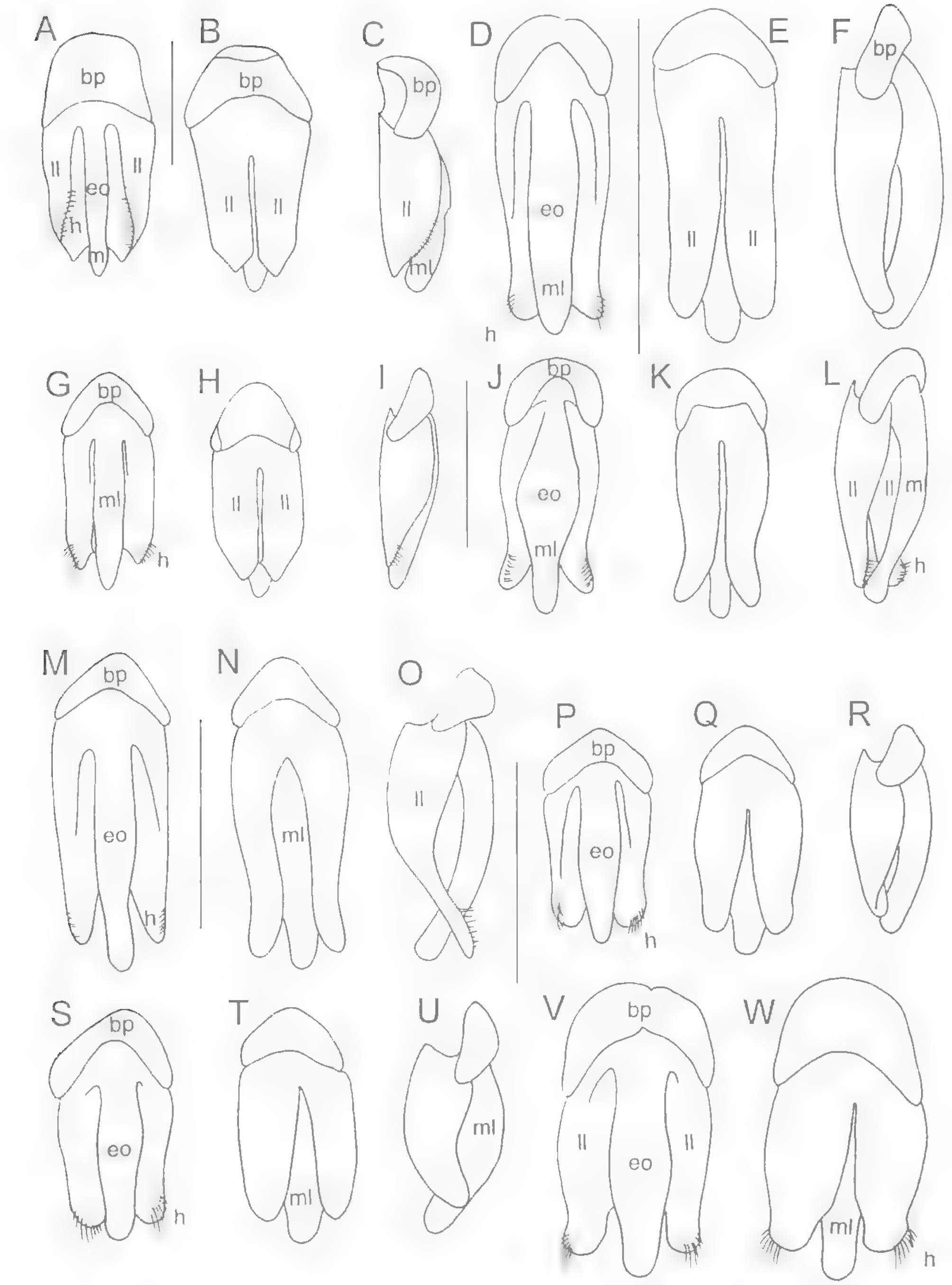


FIG. 5. Aedeagi, ♂ *Atyphella* ; A, D, G, J, M, P, S, V, ventral aspect; B, E, H, K, N, Q, T, W, dorsal aspect; C, F, I, L, O, R, U, right lateral aspect. A-C, *A. majuscula*; D-F, *A. olivieri*; G-I, *A. costata*; J-L, *A. flammans*; M-O, *A. immaculata*; P-R, *A. lychnus*; S-U, *A. similis*; V, W, *A. scintillans*. Scale lines 1mm; lines shared by: A-C & G-I; D-F & S-W; J-L; M-O; P-R. bp = basal piece; eo = ejaculatory orifice; h = hairs; ll = lateral lobe; ml = median lobe.

MATERIAL. Holotype and 11 paratypes: N QLD: same data as holotype, 4♂ (QM). 19.30S, 146.57E, Mt Elliot summit, 1150m, Jan-Mar,1991, A. Graham, PF and FIT, RF, 1♂. C QLD 21.07S, 148.31E, Pease's Lkt, Eungella, 900m, 17.xi.1992-mid April 1993, GBM & DC, RF FIT and PF, 6♂.

DIAGNOSIS. The smallest *Atyphella* species in Australia (3.6-3.9mm long); pronotum brown, elytra light brown with 2 paler interstitial lines (3, 4); mouthparts small, probably non-functional; frons-vertex junction rounded. Female and larva not associated.

DESCRIPTION. *Male*. 3.6-3.9mm long; pronotum brown, median area slightly darker than margins, pronotal punctures often ringed with brown; MS, MN and elytra light brown, except for paler suture, apex and interstitial lines (1, 2); ventral surface of thorax moderately dark brown, legs pale brown; ventral abdomen very dark brown except for white light organ in sternites 6, 7; (the dark colour of tergites 6 and 7 may be visible through the paler cuticle of sternites 6 and 7 and confuse the outline of the light organs in those segments); basal abdominal tergites light brown, tergites 5-7 very dark brown, tergite 8 pale.

Pronotum 1.1-1.2mm wide, 0.6-0.7mm long; W/L 1.8 (holotype); midanterior margin gently rounded, projecting moderately beyond rounded anterolateral corners; lateral margins slightly divergent posteriorly; disc barely depressed, lateral areas flat; punctures broad, shallow, contiguous over all of disc. Elytra with 2 well defined interstitial lines (1, 2).

Head largely concealed beneath pronotum at rest, moderate depression between eyes, GHW 0.6-0.7mm, SIW less than 0.1mm, ASD < ASW but sockets not contiguous; frons low, height subequal to ASW, and frons-vertex junction rounded; mouthpart complex small, probably non-functional; apical segment of labial palpi fusiform. Antennal length subequal to GHW, with 6-9 flagellar segments; FS 1 elongate, narrowed at base, about 3 times as long as each of the remaining subequal FS.

Abdomens of most specimens examined are shrivelled and distorted and description relates to holotype only. Light organs (Fig. 3C) occupying sternites 6 and 7 entirely, (apparently retracted to anterior 2/3 in sternite 7 in damaged paratypes); MPP of sternite 7 moderately produced, apically rounded; lateral margins of tergite 8 taper posteriorly, median posterior margin of tergite 8 rounded, and projecting a little beyond postero-lateral corners.

Aedeagus L/W 3.5; basal piece not hood like; ML not expanded at level of EO or at apex, and projecting beyond apices of lateral lobes a little and curving slightly dorsally; LL slightly expanded at their apices, widely separated along their dorsal length.

DISTRIBUTION. Far N Qld on the upper parts of Mt Elliot in rainforest, and at Eungella; never below 900 metres.

REMARKS. This small distinctive species is named from its type locality. It and *A. flammans* are the only two *Atyphella* which occur both north and south of the dry barrier between Townsville and Mackay.

Atyphella flammans Olliff
(Figs 1, 4, 5, 7, 12, 36B)

Atyphella flammans Olliff, 1890: 651. Lea, 1909: 111; 1921b: 68. Olivier, 1910: 40. Ballantyne in Calder, 1998: 176 (comb. rev.).

Luciola (Luciola) flammans (Olliff). McDermott, 1966: 104

TYPE. Lectotype, ♂ (designated here), 20.42S, 140.30E, Cloncurry (K33979, AM). Of two ♂ on the one card bearing a holotype label, this specimen on the left has a relatively intact head (missing antennae). Chosen as lectotype as nature of frons-vertex junction is essential in distinguishing this and other similarly coloured species. Paralectotype, second ♂ on same card as lectotype, this specimen is missing its head, and has abdomen and aedeagus dissected; otherwise labelled as for lectotype (AM).

MATERIAL. Lectotype, paralectotype and 103 specimens. N QLD: 15.42S, 145.13E, Bloomfield Rd., via Helenvale, 2.x.1974, GBM, 1♂ (QM). Mt Finnigan, via Helenvale, 850-950m, 3-5.xii.1990, GBM, 1♂. 16.03S, 145.25E, Mt Halcyon, 870m, 22-24.xi.1993, GBM, 2♂. 16.05S, 145.17E, Gold Hill, McDowall Ra., 1.xi.1976, TW & R. Taylor, 2♂ (ANIC). 16.05S, 145.26E, Tribulation transect site 7, 700m, RF, 19.xi.1998, GBM, P. Bouchard, A. O'Toole; 1♂ (QM). 16.08S, 145.26E, Noah Ck, 7km ENE of Thornton Peak, 27.iii.1984, A. Calder & TW, ANIC berlesate 946, lowland RF, 1 larva (ANIC). 16.45S, 145.37E, Black Mt Rd 7km NNW of Kuranda, 30.iii.1985, 400 m, A. Calder & TW, ANIC berlesate 949, RF, 1 larva. 16.49S, 145.38E, Kuranda, F. P. Dodd, 3♂ (SAM, ANIC, MV). 6kms NW of Kuranda, 6.xi-10.xii.1984, RS & Halfpapp, 1♂ (DPI). 16.55S, 145.46E, Cairns: 3♂, (QM, ANIC). Crystal Cascades, via Cairns, 9.xii.1964, GBM, LP, 7 larvae (T.121, UQ); 12.xi.1965 GBM, 1♂ (T.180). 30.xi.1965, GBM, 1 larva (T.199); 6.xii.1966, BC, 1♂ (T.211). 17.07S, 145.41E, Upper Mulgrave R 1.xii.1965, GBM, 1♂ (T.178). Little Mulgrave R, HH, 2♂ (SAM). 17.16S, 145.53E, Bellenden Ker Ra., 1km S of Cable Tower 6, 25-31.x.1981, 500m, Earthwatch/Q Museum berlesate 321, RF sieved litter, 1 larva (ANIC). 17.17S, 145.57E, Graham Ra., 350m, 1.xi-8.xii.1995, GBM, FIT, 1♂ (QM). 17.34S 145.55E Coorumba, R. Mulder,

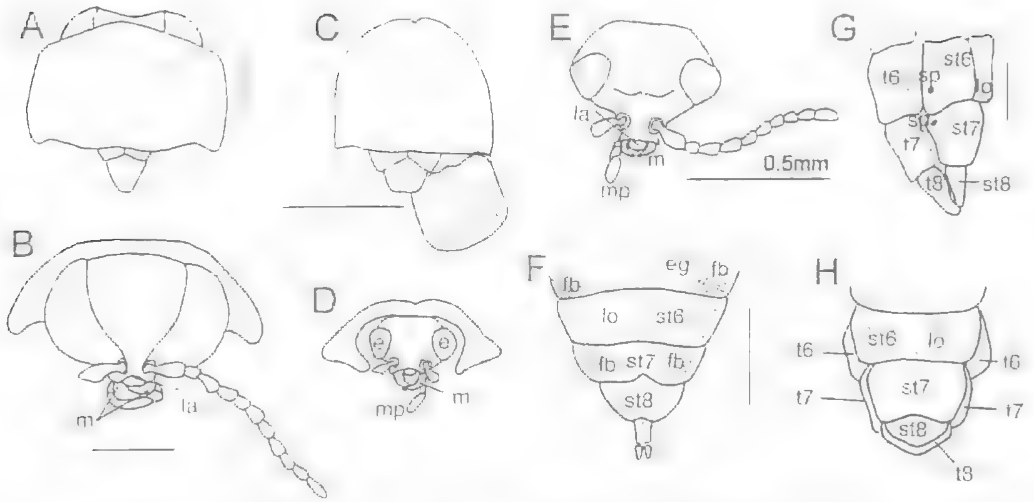


FIG. 6. ♀ *Atyphella*. A, C, dorsal aspect pronotum including head and mesonotal plates (A), and mesonotal plates and right elytron (C); B, D, E, anterior aspect head with pronotum (B, D); F-H, terminal abdomen, lateral (G) and ventral (F, H). A, B, *A. costata*; C, D, *A. inconspicua*; E, F, *A. atra*; G, H, *A. conspicua*. Scale lines 1mm; lines shared by D, F; G-H. e = eye; eg = egg; fb = fat body; la = labrum; lo = light organ; m = mandible; mp = maxillary palp; sp = spiracle; st 6-8 = sternites 6-8; t6-8 = tergites 6-8.

29-30.x.1985, 10♂; 15.xi.1985, 9♂ (AM). 17.36S, 145.45E, Henrietta Ck, 6.xii.1965, GBM, 1 larva (T.191, UQ, taken with larvae of *A. olivieri*). 17.52S, 146.07E, Clump Point, 60mi. S of Cairns, ix.1951, J. Sedlacek, 2♂ (CAS, MV); 23.x.1951, J. Campbell, 2♂ (MV). 17.53S, 146.06E, Mission Beach, 10.xi.1965, GBM, 4♂ 4 larvae (2♂ T.179 UQ, 2♂, 2 larvae T.200, 1 larva T.244; 1 larva QM); x.1951, J. Sedlacek, 1♂ (UQ). 18.39S, 146.10E, Broadwater Park, 35km NW of Ingham, 21-22.xii.1986, S.H., 2♂ (QM). 21.01S, 148.36E, 15km NE of Eungella, 18.xi.1981, A. Gillison, 950m, berlesate, meso-notophyll forest 25, 3 larvae (ANIC). 21.09S, 149.11E, Mt Blackwood, 28km NW of Mackay, 3.vii.1991, 590m, GBM, HJ, 1 larva, 1♂, 2 ♀, eggs and 7 first instar larvae (QM). 21.10S, 148.31E, Broken R, Eungella, 750m, 16-17.xi.1992, GBM, 27♂. 21.37S, 148.59E, Stony Ck, 280m, 4.x-17.xii.1999, FIT, DJC, 9♂.

DIAGNOSIS. Male often large (8-13mm long); pronotum cream with median dark markings; elytra moderately dark brown, with lateral, sutural and apical borders cream, and interstitial lines 2, 3, 4 cream where they traverse the brown area; elytra slightly convex sided when closed; antennal sockets contiguous or nearly so; mouthparts small, may be non-functional; frons-vertex junction convex. Female with fully developed elytra and abbreviated hind wings. Larva dorsally cream with patchy brown markings on tergites 2, 3 and abdominal tergite 5.

DESCRIPTION. Males are redescribed; females and larvae are newly described.

Male. 8-13mm long (lectotype 10mm); pronotum cream, with median dark markings, MS and MN cream; elytra brown with broad lateral margin, apex, sutural margin, humeral angle and interstitial lines 1-3, cream; head antennae and palpi dark brown; ventral pro and mesothorax cream, metathorax dark brown; legs 1, 2 dark brown except for pale coxae, trochanters and base of femora; ventral abdomen dark brown, almost black, except for cream sternites 6 & 7; basal tergites brown, tergites 7 & 8 pale; 7 sometimes dingier than 8 but paler than rest.

Pronotum (Fig. 11) 2.8-4.4mm wide, 1.5-2.3mm long; W/L 1.8-2.6 (lectotype 2.0); midanterior margin sometimes slightly indented, moderately produced beyond anterolateral angles; lateral margins diverging posteriorly in anterior 3/4-5/6 with no convergence in posterior 1/6, or convergent in posterior 1/6; midposterior margin broadly indented; punctures broad, shallow, may be separated by their width in median area of disk, remainder mostly contiguous. Elytra slightly convex-sided when closed, with interstitial lines 1, 2 well developed and reaching to apical 1/8, 3 not as well elevated as 1, 2, usually effaced in front and behind and occupying about 1/4 length of elytron, 4 visible and elevated, sometimes slightly so; line 4 in lectotype is well developed; (Bloomfield Road male has line 3 almost as long as rest and line 4 well elevated).

Head almost concealed beneath pronotum at rest; deeply depressed between eyes; GHW 1.9-2.7mm; SIW 0.2-0.3mm; antennal sockets contiguous; frons scarcely defined and 1-2 × ASW (2 × ASW in lectotype); frons-vertex junction rounded; mouthpart complex small, probably non functional; apical segment of labial palpi flattened and dentate. Antennal length subequal to GHW; FS 1 almost as long as scape, FS 2,3 subequal and slightly shorter than FS 1, 4-8 subequal, about as long as broad, 9 longer than broad, and apically rounded.

Terminal abdomen on lectotype and paralectotype mutilated and this description relates to other specimens examined. Sternite 7 MPP moderately produced beyond rounded posterolateral corners and apically rounded; light organ of sternite 7 does not extend into the MPP. Tergite 8 with rounded posterior margin (Fig. 4J,K). Aedeagus L/W 3; basal piece not hood like; ML very broad around ejaculatory orifice, and narrowing just before slightly bulbous apex; LL narrowing before their apices and diverging slightly along their length, widely divergent in apical 1/6; hairs borne along apical 1/4 (Fig. 5J-L).

Female. 10mm long; fully developed elytra not covering gravid abdomen entirely and expanding slightly in posterior half; hind wings about 3/4 as long as elytra, flightless; coloured as for male, except for pale sternites 8, 9 and elytra may have light brown colouring restricted to basal 1/4 (darker hind wings visible beneath pale elytra may confuse interpretation of this dark basal area). Pronotal outline as for male. Elytra convex-sided when closed; with 4 well-defined interstitial lines, lines 2 and 3 converging in apical 1/6. Head very small, of form of wingless female head; mouthparts well developed; posterior margin of abdominal sternite 8 entire; median posterior margin of sternite 9 indented.

Larva. (Figs 12A, 36B); lateral margins of terga 1-11 bearing fine short hairs and spines, not conspicuously thickened or ridged; median line on terga 2-11 not laterally ridged; punctures in anterior half of terga 2-10 not conspicuously larger than rest. Protergum 1.1-4.0mm long; 1.8-6.5mm wide; median anterior area of protergum slightly narrowed and median anterior margin indented; lacking tubercles; posterolateral corners of thoracic and abdominal terga (except tergum 12) rounded. Posterolateral corners of terminal abdominal tergum slightly produced. Head wider than long; anterior margin laterally and medially emarginate (Fig. 7M).

Dorsally yellowish with dark brown markings; protergum with brown area along midanterior margin, lateral areas clear yellow, remainder marked lightly and patchily in brown; meso and metaterga deep cream- light brown, with small dark brown areas at anterolateral and posterolateral angles, and median area mid-dark brown; metatergum with extensive median dark brown area which widens posteriorly; abdominal terga very lightly marked in brown, except for paired small dark brown areas along midanterolateral margin of terga 4-11, and a median dark area on tergum 8; tergum 12 cream with brown markings; legs dark brown; thoracic sternal plates lightly marked with pale brown; thoracic epipleural plates dark brown; sternal plates of abdominal segments 4-10 mainly cream with light brown markings; epipleural plates of segments 4-9 dark brown with wide cream areas; epipleura of segments 9-10 cream; ventral surface of segments 10-11 pale.

DISTRIBUTION. Modern records show the species is widespread in the Wet Tropics of N Qld, ranging from just north of the Bloomfield R south to near Ingham. Farther south it has been taken at two localities near Mackay and Sarina. All these records are from tropical coastal habits, mostly in lowlands. By contrast the original types are labelled ‘Cloncurry’ which is an arid rocky region from which it has never been recollected. The Cloncurry locality requires modern confirmation and the locality is consequently omitted from distribution maps (Figs 8, 11).

REMARKS. Second largest Australian firefly. Specimens taken at Crystal Cascades near Cairns flew slowly at about head height and were easily netted.

Atyphella flammulans Ballantyne sp. nov. (Figs 1, 4)

TYPE. Holotype.♂, N Qld 17.56S, 145.56E, Boulder Ck via Tully, 24-27.x.1983, 500-600m, GBM, DY, GT (QMT61110).

MATERIAL. Holotype and 30 paratypes. N QLD: 17.17S, 145.54E, Bellenden Ker Base Stn, 100m, 28.viii-20.x.1991, FIT, GBM and HJ, 7♂ (QM). Bellenden Ker Ra., Cable station 5, ix-x.1982, malaise trap, S. Montague, 1♂. 17.28S, 146.01E, Stone Ck, 1.x-1.xi.1995, 100m, FIT, J. Hasenpusch, 11♂. 17.36S, 146.00E, 15km WNW S Johnstone, 29.ix.1986, light trap, Faveri and Halfpapp, 1♂ (DPI). 17.47S, 145.34E, Tully Falls SF, 18km SSW of Ravenshoe, 1.x-5.xi.1987, 730m, RS & Dickinson, 2♂ (QM). Ravenshoe SF, Tully Falls Road, 10.x-15.xi.1987, RF FIT, AWH, 2♂ (OTT). 17.56S, 145.56E, Boulder Ck via Tully, 24-27.x.1983, 500-600m, GBM, DY, GT, 5♂ (QM). 17.56S, 145.56E, Upper Boulder Ck via Tully, 24-27.x.1983, 650-900m, GBM, DY, GT, 1♂.

DIAGNOSIS. Similar to *A. flammans*, differing in the smaller size (6-8.6mm long), the elytral colouration, the presence of only two well defined interstitial lines, the high frons and acutely margined frons-vertex junction.

DESCRIPTION. *Male*. 6-8.6mm long; pronotum pale clear cream with median dark brown marking (Fig. 1K); MS and MN pale cream; elytra moderately dark brown with pale cream lateral margin, apex, sutural margin, and interstitial lines 1, 2 (sometimes with traces of a short pale interstitial line 3); head dark brown, antennae and palpi mid brown; ventral surface of pro and mesothorax pale brown, of metathorax brown, darker brown in median area; legs 1 and 2 with pale semitransparent coxae, trochanters and femora, and brown tip of femora and tibiae and tarsi; legs 3 similarly coloured except for brown ventral face of coxae; abdominal sternites moderately dark brown except for pale light organ in sternites 6 and 7; abdominal tergites pale to dark brown except for paler brown tergite 8.

Pronotum (Fig. 1K) 1.4-1.6mm long; 2.4-3.0mm wide; W/L (holotype) 1.7; midanterior margin broadly rounded, projecting beyond rounded anterolateral corners; lateral margins divergent posteriorly, sometimes converging in posterior 1/4; punctures broad, shallow, contiguous. Elytra slightly convex-sided when closed, with 2 well-defined interstitial lines (1, 2) and faint traces of line 4 at base near humeral angle.

Head partially concealed beneath pronotum at rest; deeply depressed between eyes; GHW 1.5-2.0mm; SIW 0.1-0.2mm; antennal sockets contiguous; frons high, 5-6 times ASW; frons-vertex junction narrowly acute; mouthparts small; apical segment of labial palpi dentate. Antennal length subequal to or slightly > GHW; FS 1, 2 subequal in length, FS 1 narrower than 2; FS 2, 3, 4 subequal in width, 2 slightly longer than 3 which is slightly longer than 4; FS 5-9 shorter than 4, subequal in length.

Light organs (Fig. 4G) occupying anterior half or less of sternites 6 and 7 or retracted from all margins in sternite 6 (this may be a post mortem change); in sternite 7 irregular patches of fat body behind the well defined light organ material do not extend more than 2/3 median length of this sternite; MPP of sternite 7 moderately produced and apically rounded; posterior margin of tergite 8 rounded. Aedeagus like that of *A. flammans*; ML projecting strongly between apices of LL which are separated along their length dorsally with their apices divergent.

Female and Larva. Unknown.

DISTRIBUTION. Rainforest species, restricted to blocks 13 and 14 in the central part of the Wet Tropics, N Qld. It occurs from lowlands to moderately high elevation (Fig. 11).

REMARKS. The specific name *flammulans* was chosen not to represent its light pattern, which is unknown, but to emphasise its similarity to *A. flammans*.

Atyphella immaculata Ballantyne sp. nov.
(Figs 4, 5)

TYPE. Holotype.♂, N Qld: 15.49S, 145.17E, Mt Finnigan, RF, 760 m, via Helensvale, 20-27. vii. 1974, GBM, DC (QMT61139).

MATERIAL. Holotype and 22 paratypes. N QLD: same locality as holotype, 8♂ (QM). 17.00S, 145.26E, 26km up Tinaroo Ck Rd, via Mareeba, 24.viii-29.ix.1983, RS & Brown, MDPI FIT, 1♂ site 8, 1♂ site 7 (DPI). 17.16S, 145.29E, Atherton, 6.x.1959, G. Ettershank, 1♂ (T.4, UQ). 17.21S, 145.36E, Malanda, 29.ix.1930, A.J. Turner, 2♂ (QM). 17.25S, 145.28E, Hugh Nelson Ra., 21km S of Atherton, 3.ix-1.xi.1984, MDPI FIT site 16, 1♂ (DPI). 17.33S, 145.32E, BS2 Mt Fisher, FIT JCU, 3.x-2.xi.1996, L. Umbach, 1♂; 1150m, malaise trap, 2♂ (ANIC). 17.37S, 145.34E, BS3 Massey Ck, 1000m, 3.x-2.xi.1995, L. Umbach, 5♂ (3 in FIT).

DIAGNOSIS. Male moderately large (7-9mm long); pronotum orange; elytra dark brown with 3 well developed interstitial lines; distinguished from *A. majuscula*, which has similar dorsal colouration, by its smaller size, parallel-sided elytra with 3 interstitial lines, and absence of a hood like basal piece of the aedeagus.

DESCRIPTION. *Male*. 7-9mm long; pronotum uniformly orange yellow; MS and MN paler orange; elytra moderately to very dark brown; head reddish brown, antennae and palpi moderately dark brown, apical segment of maxillary palpi pale on inner face; ventral surface of pro and meso thorax yellow, of metathorax mid-brown; legs yellow except for dark brown apices of femora, and all of tibiae and tarsi; ventral surface of abdomen shiny dark brown except for waxy white sternites 6 and 7; basal abdominal tergites dark brown, tergites 6, 7 and 8 pale with scattered light brown markings, tergite 6 sometimes dark brown.

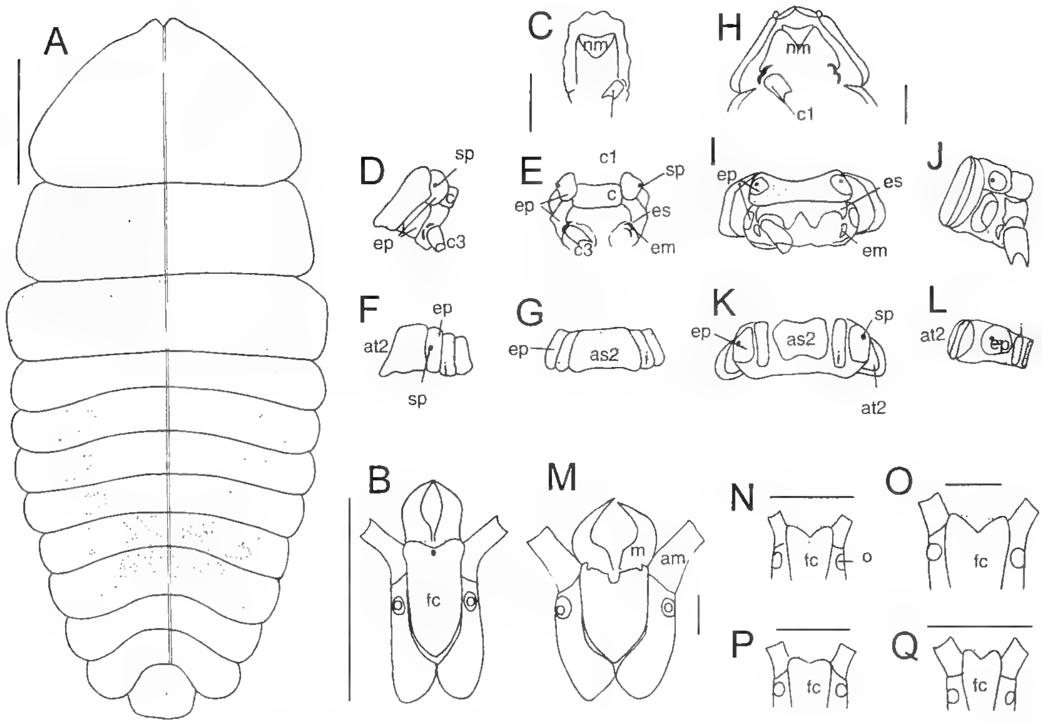


FIG. 7. Larval morphology. A, dorsal aspect; B, M, dorsal aspect larval head with base of antennal articulating membrane and mandibles; C, H,ventral aspect pronotum with head removed; D, E, J, I, lateral and ventral aspects thoracic segment 3; F, G, L, K, lateral and ventral aspects abdominal segment 2; N-Q, dorsal aspect of anterior half of larval head (semidiagrammatic). A, B, *A. atra*; C-G, *Luciola australis*; H-L, *Atyphella scintillans*; M, *A. flammans*; N, *A. olivieri*; O, *A. scintillans*; P, *A. similis*; Q, *A. lychnus*. Scale lines 1mm: lines shared by: C-G; H-L. am = antennal membrane; as2 = abdominal sternite 2; at2 = abdominal tergite 2; c = complementary segment; c1, c3 = coxae = legs 1 and 3; ep = epipleurum; es = episternum; fc = frontoclypeus; i = intrasegmental membrane; m = mandible; nm = neck membrane; o = simple eye; sp = spiracle; t3 = thoracic tergite 3.

Pronotum 2.2-3.0mm wide; 1.3-1.6mm long (W/L holotype 2); midanterior margin rounded and may project considerably beyond anterolateral corners; punctures broad, shallow, contiguous. Elytra parallel-sided, with 3 well-defined interstitial lines (1, 2, and 4).

Head partially concealed beneath pronotum at rest; moderately depressed between eyes; GHW 2.0-3.2mm; SIW 0.2-0.3mm; ASD < ASW; antennal sockets slightly protuberant; frons 1-2 × ASW and frons-vertex junction rounded; mouthparts well developed; apical segment of labial palpi fusiform. Antennal length subequal to GHW; FS 1-4 longer than wide; FS 5-8 subequal and about as long as wide.

Light organs (Fig. 4B) occupying sternites 6 and 7 except for a narrow posterior margin of 7; MPP of sternite 7 scarcely developed and posterior margin of sternite 7 broadly rounded; lateral margins of tergite 8 subparallel and posterior margin gently rounded (Fig. 4E). Aedeagus (Fig. 5M-O) L/W 2.5; basal piece not hood-like; ML not conspicuously swollen around EO or at apex, often protuberant dorsally between apices of LL which are very narrow in lateral aspect, widely separated along their dorsal length and slightly divergent at their apices; hairs restricted to apical 1/3 or less.

Female and Larva. Unknown.

DISTRIBUTION. Restricted to the Wet Tropics of N Qld where it occurs on Mt Finnigan (block 1), and along the western edge of the central mountain system (blocks 7, 9 &10). Strictly an upland rainforest species, ranging from 750-1200m (Fig. 13).

REMARKS. The specific name, *immaculata*, meaning 'spotless' highlights its uniformly

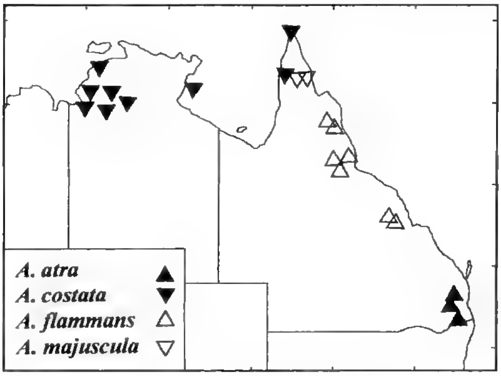


FIG. 8. Records for four Australian species of *Atyphella*.

coloured pronotum. This is one of only two Australian *Atyphella* species (the other is *A. majuscula*) which possess this dorsal colouration of orange pronotum and black elytra, a pattern associated with Australian and New Guinean *Luciola* and *Pteroptyx* (Ballantyne, 1987a,b).

Atyphella inconspicua (Lea)
(Figs 1, 2, 3, 6)

Luciola inconspicua Lea, 1921a: 197.
Luciola (Luciola) inconspicua Lea. McDermott, 1966: 106.
Atyphella inconspicua (Lea) comb. nov. Ballantyne in Calder, 1998: 177.

TYPES. Lectotype. ♂ (here designated). N Qld: 16.55S, 145.46E, Cairns district, E. Allen, male (of 2♂ mounted on card, the lectotype is mounted ventral side facing up; labels are: 1. *Luciola inconspicua* Lea Cotype Cairns; 2 C/2289; 3 Cotype) (QM). Paralectotypes, 19♂, same data as lectotype, (1 QM; 4, SAM; 4, AM; 6, MV; 2, ANIC; 2 BMNH).

MATERIAL. Lectotype, paralectotypes and 279 specimens. N QLD: no other information, 13♂ (CAS). 15.53S, 145.13E, Mt Misery Rd, 730m, 2.i.1991, ANZSES, pyrethrum knockdown, 1♂ (QM). 16.37S, 145.20E, top of Mt Lewis, 27.xi.1965, GBM, 1♂ (T.189, UQ). 16.55S, 145.25E, Mt Halcyon, 870m, 22-24.xi.1993, GBM, 2♂ (QM). 16.55S, 145.40E, Mt Williams, 900-1000m, 2-3.xii.1993, Cook, GBM and HJ, 7♂. 17.02S, 145.38E, Lambs Head, 10km W of Edmonton, GBM, GT, 12-13.xii.1988, 1200m, 23♂; 8-9.i.1990, 11♂. 17.03S, 145.41E, Upper Isley Ck, 750m, 29-30.xi.1993, DC et al., 10♂. 17.06S, 145.53 E South Bell Peak, Malbon Thompson Ra., 900m, 21-22.xi.1990, GBM, 8♂. 17.12S, 145.51E, Bellenden Ker Ra., 1km S of Cable Tower 6, 17.x-5.xi.1981, 500m, Earthwatch, QM, 28♂ (ANIC). 17.27S, 145.29E, Tower nr The Crater NP, 1230m, PF traps, 25.xi.1994-10.i.1995, GBM, 2♂ (QM). The Crater nr Herberton, xii. 1961, DKM, Lossin, 2♂ (AM). 17.31S, 145.37E, Millaa Millaa Falls, 5.xii.1965, GBM, 4♂ (T.197, UQ). 17.33S, 145.32E, Mt Fisher, 1150m, 1.xii.1994-3.i.1995, PZ, 2♂ FIT JCU East, 1♂ FIT JCU West (ANIC). 17.36S, 145.45E, Henrietta Ck, 6.xii.1965, GBM, 2♂ (T.185, UQ). 17.37S, 145.34E, BS 3 Massey Ck, 1000m, 3.x-2.xi.1995, L. Umbach, FIT JCU, 1♂ (ANIC). 17.50S, 145.56E, Tully R Xing, 10km S of Koombooloomba Dam, 4-5.i.1990, 750m, GBM, SRM, 3♂ (QM). 17.56S, 145.56E, Upper Boulder Ck, 11km NNW of Tully, 900m, 25-27.x.1983, 850 m, GBM, DY, GT, 10♂; GBM, GT, HJ, 16-19.xi.1984, 20♂, 4-5.xii.1989 at 800m, 1♂, 5-7.xii.1989, at 1000m, 12♂. Boulder Ck, via Tully, 500-600m, 24-27.x.1983, GBM, DY, GT, 35♂, 8♀. 18.12S, 145.45E, Kirrama Ra., Douglas Ck Rd, 800 m, 9-12.xii.1986, GBM, GT, SH, 65♂, 1♀ (taken with 2♂ *A. olivieri*, and 2♂, 4♀ *L. nigra*). 18.16S, 146.01E, Kirrama SF, via Cardwell, 16.xii.1966, BC, 1♂ (T.217 UQ, taken with 1♂ of *A. olivieri*). Kirrama Ra., Yuccabine Ck area, 600m, 9-12.xii.1986, GBM, GT, SH, 1♂ (QM).

DIAGNOSIS. Male small to medium (5-7.6mm long; lectotype 5.3mm); pronotum subparallel sided, cream with median dark brown markings; elytra light to moderately dark brown with 3 interstitial lines (which may be paler than rest) which are bordered by dense, large punctures; punctures appear dark brown in paler elytra; ASD subequal to or slightly smaller than ASW; mouthparts well developed; frons-vertex junction acute; head partially concealed beneath pronotum at rest. Presumed female brachelytral, differing from *A. conspicua* by the pronotal outline and nature of the pronotal punctures. Larva unknown.

DESCRIPTION. Males are redescribed; females are newly described.

Male. Small to medium; 5-7.6mm long; (lectotype 5.3mm); pronotum dull cream with median light to dark brown marking may extend across median half or greater; MS and MN cream; elytra uniformly light to medium brown; interstitial lines, and suture especially at base, may be paler than rest in which case punctures appear darker brown; head moderately dark, sometimes reddish brown, antennae and palpi paler brown; ventral pro and mesothorax pale, metathorax dark brown; legs 1, 2 cream with dark brown tarsi; legs 3 brown with cream femora; ventral abdomen dark brown except for pale cream sternites 6, 7; dorsal abdomen light brown except for pale cream tergites 7, 8.

Pronotum (Fig. 1E) 1.5-2.8mm wide; 1.0-2.4mm long; W/L 1.8 (lectotype); midanterior margin moderately projecting beyond rounded anterolateral corners; lateral margins subparallel-sided; acute posterolateral corners often project moderately beyond straight median posterior margin; punctures broad, mainly contiguous. Elytra parallel-sided when closed;

with interstitial lines 1, 2 well defined, and fainter traces of 4; elytral punctures broad, relatively shallow and conspicuous.

Head (Fig. 2C) partially concealed beneath pronotum at rest, deeply depressed between eyes; GHW 1.2-1.5mm; SIW 0.2mm; ASD usually < ASW (ASD is subequal to ASW in Upper Isley Ck males in QM, and subequal to 1/2 ASW in Lamb's Head males in QM); frons vertical, 3 × ASW high; frons-vertex junction well defined, narrowly acute; mouthparts well developed; apical segment of labial palpi fusiform. Antennal length slightly shorter than GHW; FS 1 about as long as scape, but narrower; FS 2, 3, 4 subequal; FS 5-8 subequal, slightly shorter than elongate, slender FS 9.

Light organs (Fig. 3G,H) occupying sternites 6, 7 completely except for a narrow posterior margin of 7; MPP of sternite 7 gently produced and apically rounded; posterior margin of tergite 8 rounded, lateral margins subparallel. Aedeagus L/W 1.9; with ML bulbous around EO and slightly bulbous at apex; LL convex-sided, divergent along their length dorsally and slightly bulbous at their apices.

Female. 6-9.5mm long; associated by similarity of label data only; brachelytral, and lacking hind wings (Fig. 6C,D). Pronotum pale brown with median darker brown marking, elytra paler brown with pale cream interstitial lines; head light brown, antennae very pale brown, rest of body pale cream and semitransparent.

Pronotum broadly rounded anteriorly, slightly indented in median anterior margin, anterolateral angles obliterated; lateral margins subparallel; posterolateral corners project slightly; surface scarcely depressed; punctures broad, shallow, contiguous. Elytra shorter than pronotum, with 3 well-defined interstitial lines, and contiguous in median line even when abdomen gravid. Head small, barely depressed between eyes, of wingless female head form (Fig. 6D); mouthparts well developed. Light organ in sternite 7 retracted from all margins; median posterior margins of sternites 8 and 9 not indented.

DISTRIBUTION. Common at many rainforest localities in the Wet Tropics zone, from rainforest block 1 south to block 15; usually above 500 metres (recorded up to 1330m). Old records of 'Cairns district' probably were not taken at sea level because modern collectors have not taken the species in lowlands. Taken with the similar *A. conspicua* at only 2 localities (Fig. 10).

REMARKS. Lea (1921a) commented on the superficial similarity of this species to *Luciola cowleyi*, and considered that *inconspicua* could have been assigned to either *Atyphella* or *Luciola*. There is a colour similarity only between distinctive species in 2 different genera.

Atyphella lewisi Ballantyne sp. nov.
(Fig. 4)

TYPE. Holotype. ♂ N Qld, 16.37S, 145.20E, Mt Lewis Road, via Julatten, 1000m, 11 Nov-25 Dec 1987, AWH, RF, FIT (ANIC).

MATERIAL. Holotype and 41 paratypes. N QLD: 15.42S, 145.13E, Mt Finnigan summit, via Helenvale, 28-30.xi.1985, 1100m, PF traps in RF, GBM, DC, 4♂ (QM). 15.48S, 145.17E, Mt Finnigan, 1060m, 4.xii1990 – 17.i.1991, Q. Mus, Anzses, FIT 4, 1♂. 15.43S, 145.17E, Big Tableland, NE corner, 21.xii.1990-9.i.1991, 618m, ANZSES FIT, 4♂. 16.05S,145.29E, Cape Tribulation, 22.ix-7.x.1982, GBM, 1♂; 4.5-5km W of top camp, 760-780m, GBM, 27.ix-7.x.1982, 1♂. 16.08S,145.17E, Cooper Ck, 13 mi. N Daintree R, 14.xi.1969, BC, 1♂ (UQ). 16.10S,145.23E, Thornton Peak, 11kms NE of Daintree, 900-1000 m, 30.x-1.xi.1983, GBM, DY, GT, 2♀ (QM). 16.28S,145.23E, Carbine Tbld, Mossman Bluff Camp, 30.xi.1990, 1000m, GBM, 3♂. Mossman Bluff Track, 5-10km W of Mossman, 20.xii.1989-15.i.1990, site 1 FIT ANZSES, 250m, GBM, 2♂. Devil's Thumb, 12km NW of Mossman, 1000m, 27.xii.1989, ANZSES expedition, 1♀. Windsor Tbld, 27.xii.1988-10.i.1989. site 2 FIT, E. Schmidt & ANSZES,1♂. Windsor Tbld via Mt Carbine, 26.xii.1983-24.i.1984, trap 15, RS & Halfpapp, 1♂ (DPI); 12.xi-26.xii.1983, FIT, site 14a, RS & AWH, 3♂. Windsor Tbld, 20.xii.1985-15.i.1986, FIT site 14d, RS & Brown, 2♂ 46km from main road, 2♂ 38km from main road. Windsor Tbld via Mt Carbine, i.1981, I Fanning 1♂ (QM). 16.37S,145.20E, Mt Lewis Road, via Julatten, 1000m, 11 Nov-25 Dec 1987, AWH, RF, FIT, 3♂ (ANIC). 16.37S,145.20E, Mt Lewis Road, 16km from highway, 18 Dec 1989-13 Jan 1990, 950m, FIT, GBM, GT, ANZSES site 2, 2♂ (QM). Top of Mt Lewis, 27.xi.1965, GBM, 6♂ (T. 11, 190 UQ). 5km N of Mt Lewis, via Julatten, 3.xi.1983, 1040m, pyrethrum knockdown in RF, DY and GT, 1♂ (QM).

DIAGNOSIS. Small species (4.8-5.7mm long), superficially similar to *A. brevis* and *A. ellioti*, distinguished from the former by the smaller size, presence of only 2 well defined interstitial lines, and a convex frons-vertex junction, and from the latter by the colouration of the pronotum and the terminal abdominal tergites and from all other Australian Lampyridae by the reduced area of the light organ in sternite 7. Female tentatively associated.

DESCRIPTION. *Male*. 4.8-5.7mm long; pronotum cream with median dark area sometimes occupying median half or greater (pronotum entirely dark brown in one Cape Tribulation ♂); MS and MN cream, often with darker brown median markings; elytra light to medium brown, often shiny, with pale wide lateral margin (extending to and including the pale interstitial line 4), pale interstitial lines 1, 2 and narrowly pale suture and apical margin; head dark brown, antennae and palpi paler brown; ventral thorax pale brown, legs pale brown except for darker brown tibiae and tarsi; abdominal tergites pale brown; basal abdominal sternites moderately dark brown; light organ in sternite 6 appears as a condensed yellow area in median area (Fig. 4H) with remainder being paler and more diffuse fat body material; in sternite 7 the condensed light organ material is restricted to lateral yellowish plaques separated by diffuse fat body.

Pronotum 0.8-1.0mm long, 1.7-1.8mm wide. W/L (holotype) 2.2; midanterior margin rounded, projecting moderately beyond rounded anterolateral corners; lateral margins divergent posteriorly in anterior 3/4 at least; punctures broad, shallow, mostly contiguous, punctures in median area may be separated by their width. Elytra slightly convex-sided when closed; with 2 well-defined interstitial lines (1, 2) and fainter traces of line 4, which may be effaced posteriorly.

Head partially concealed beneath pronotum at rest; deeply depressed between eyes; GHW 1.1-1.3mm; SIW 0.1mm; antennal sockets contiguous; frons not well defined, about twice ASW and sloping into frons such that the frons-vertex junction is not clearly defined; mouthparts small and adult may not feed. Antennal length subequal to GHW; FS1 narrower at base than remaining FS, and slightly longer and wider than 2; FS 2, 3 subequal in length, slightly longer than 4-9 which are subequal in length and width. Apical segment of labial palpi fusiform.

Light organ material in sternite 6 closely adpressed to underside of sternite in area indicated (Fig. 4H) remaining area of this sternite occupied by fat body; light organ material in sternite 7 appearing bipartite, with 2 condensed lateral plaque like areas united by fat body; this may be a post-mortem change; no information is available on light production to indicate the true extent of the light producing areas in sternite 7; MPP of sternite 7 broadly rounded; posterior margin of tergite 8 rounded. Aedeagus with basal piece not hood like; LL separated dorsally; ML not bulbous around EO or at apex, a little longer than lateral lobes and may project slightly dorsally through their apices.

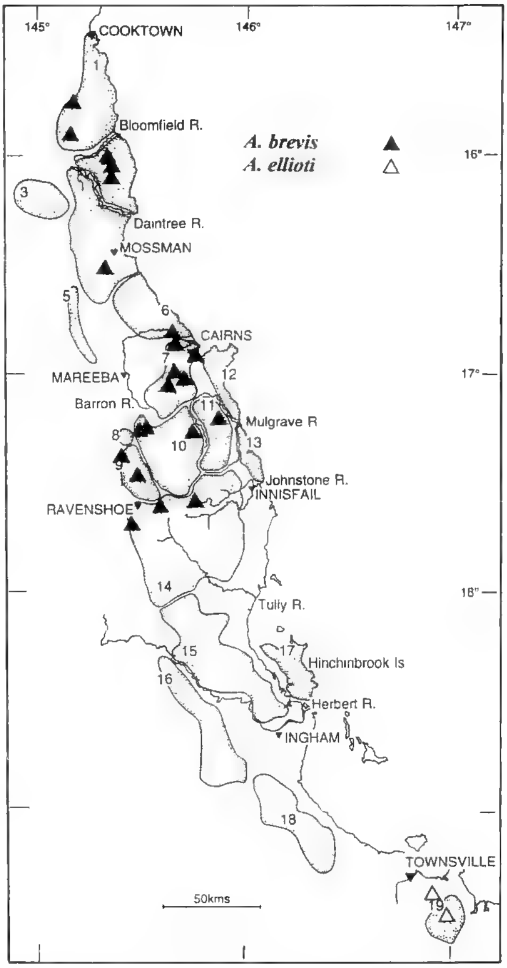


FIG. 9. Records of *Atyphella brevis* and *A. ellioti* in far north Queensland rainforests.

Female. Associated by similarity of label data only; 4-10mm long; brachelytral; elytra very short, not approaching in the median line; hind wings absent; dorsal and ventral surfaces mainly very pale yellow and semitransparent except for light brown head with very dark eyes, pale brown antennae and palpi; elytra, pronotum and MN slightly darker than rest; LO yellowish.

Pronotum broadly rounded anteriorly, not indented in anterior median line; lateral margins subparallel-sided, posterolateral corners of pronotum not projecting; dorsal surface shiny, smooth, punctures small, shallow, separated by 2-3 times their width; elytra about half as long as

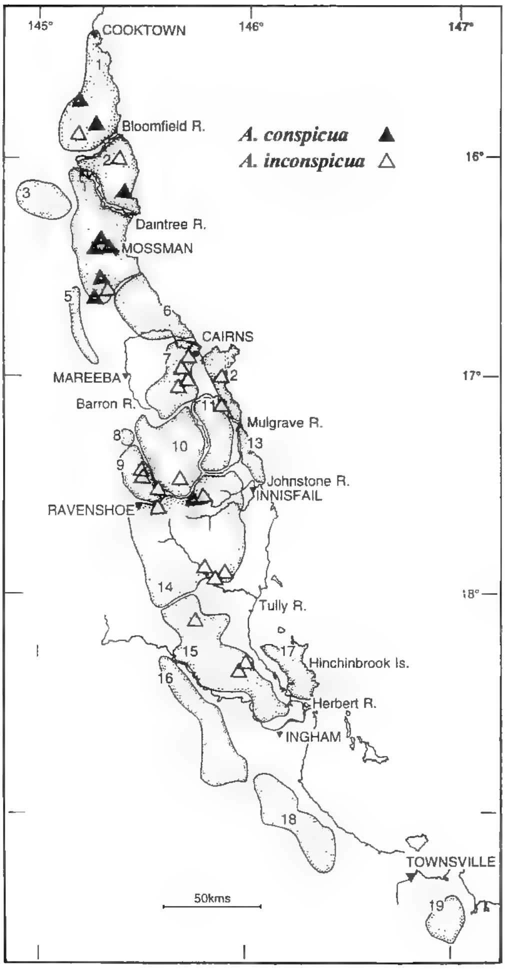


FIG. 10. Records of *Atyphella conspicua* and *A. inconspicua* in far north Queensland rainforest.

median length of pronotum, not contiguous in median line; MS very broad (about half as wide as pronotum); head small, of wingless female head form, slightly depressed between eyes; GHW = 2 × SIW; antennal length subequal to GHW; frons-vertex junction not defined. Median posterior margins of sternites 7 and 8 not indented.

DISTRIBUTION. An upland species restricted to the northern mountains (blocks 1-4) of the Wet Tropics Zone of N Qld (Fig. 13). The only record below 600m is from the Cape Tribulation coast where other upland species from adjacent mountains are also sometimes found at sea level (Monteith, 1985).

REMARKS. The species is named for its type locality.

Atyphella lychnus Olliff
(Figs 4, 5, 15)

Atyphella lychnus Olliff, 1890: 647, 1297 (female). Olivier, 1910: 47; 1911a: 172. Lea, 1909: 111; 1921c: 7. Tillyard, 1926: 213. Ballantyne in Calder, 1998: 177 (comb. rev.). *Nec* Lea, 1929: 345.
Luciola (Luciola) lychnus (Olliff). McDermott, 1966: 109. Moore, 1989: 136, Fig. 188. Lawrence & Britton, 1991: fig. 35.38, C & D (adult).
Luciola (Atyphella) lychnus (Olliff). Moore, 1989: 136.

TYPES. Lectotype. ♂ (designated here). Australia, NSW: 33.30S, 150.23E, Mt Wilson, Blue Mts, i.'89, Olliff; the left specimen of two syntypes mounted ventral side down on card, this specimen has head and abdomen dissected and mounted separately on the card (K33996, AM). Paralectotypes: 2♂, 2♀, larva, same label as lectotype (2♂, ♀, larva AM; ♂ and ♀ SAM).

MATERIAL. Lectotype, 5 paralectotypes and 114 specimens. SE QLD: 26.36S, 152.44E, Kenilworth SF, via Kenilworth, 20.x.1972, BC, 2♂ (UQ). 26.73S, 152.71E, Conondale, sites 12-13, 29.xi.1974, GBM, 2♂. NSW: 30.20S, 152.43E, Dorrigo, 1♂ (ANIC). 30.23S, 152.43E, Never Never Picnic area, Dorrigo NP, 29.xii.1989, A. Sundholm, 1♂ (AM). 30.43S, 152.55E, 12mi. S of Macksville, 11.xii.1967, T. Houston, 3♂ (QM, UQ). 31.58S, 151.55E, Barrington R., 4500ft., xii.1962, N.E.U. Exp. Soc., 2♂ (ANIC). 32.25S, 152.12E, Bulahdelah, 14.i.1932, Fuller, 3♂. 32.16S, 151.30E, Upper Allyn nr Eccleston, 16.xi.1965, DKM, 1♂ (AM); Upper Allyn, 26.i.1975, 9♂ 1♀. 32.34S, 151.10E, 'Tuglo', 48km N of Singleton, C. Smithers, 2♂ 6.xii.1977, 1♂ 3.xii.1977, 1♀ 27.i.1981, 1 larva 5.iv.1981, 3♂ 9.xii.1981, 1♀ 2.i.1983, 1♀ 2.ii.1983. 32.48S, 150.15E, (Mt.) Never Never, 30.xi. 1911, R. J. Tillyard, 1♂ (QM). 33.29S, 150.28E, Mt Irvine, i.1905, J. A., 2♂ (AM); 25.xii.1934, N. Plomley, 8♂ (BMNH); Smart, 1942, 3♂, 1♀ ; 29.i.1944, Mrs Messmer, 1♀ (AM). 33.30S, 150.23E, Mt Wilson, H.J. Carter, 6♂ (UQ), 7♂ i.1920 (ANIC), 1♂ i.1924; 1♂ i.1905 (MV); 6♂ 25.xii.1934 N. Plomley (BMNH). 33.42S, 150.23E, Blue Mtns, 2♂ (SAM); L. Sinclair, 3♂ (UQ), 3♂ (QM), 3♂ (ANIC), 8♂, 1♀ (MM), Grose Vale, Taylor, 2♂ (BMNH). 33.49S, 150.02E, Vicinity Jenolan Caves, 2♂ (BMNH); 1♂ (MV); J. Wilburd, 2♂, 2♀ (SAM); 2♂. 31.47S, 152.32E, 4km W of Lansdowne, Lorien, 5-6.xii.1986, H. & A. Howden, 1♂ (ANIC). 34.07S, 150.13E, Lannigan's Ck, Colong dist., nr Yerranderie, 10.xi.1927, A. Musgrave, T. Campbell, 2♂ (AM). 33.52S, 150.35E, nr Norton's Basin Nepean R, 10.xi.1921 A. Musgrave, 2♂, 1♀. 34.38S, 150.43E, Minnamurra Falls, 10mi. W of Kiama, H. & A. Howden, 2♂ 23.xii.1974, 1♂ 25.xii.1974 (OTT). 34.24S, 151.51E, Mt Keira, 20.ii.1967, GBM, 2 larvae (T.212 UQ).

DIAGNOSIS. Males 6.0-9.5mm long; pronotum cream with median dark markings; elytra light brown with paler lateral margin and 4 well defined interstitial lines which may be paler than rest of elytron. Female with fully developed

FIG. 11. Records of *Atyphella flammans* and *A. flammulans* in far north Queensland rainforest.

elytra and shortened hind wings, dorsally dingy cream. Larva dorsally cream with very extensive dark markings; similar to *A. scintillans* but lacking pronotal tubercles.

DESCRIPTION. Males, females and larvae are redescribed.

Male. 6.0-9.5mm long; pronotum dingy cream with median brown markings occupying median half or less; MS and MN dingy cream; elytra light-medium brown with interstitial lines and margins slightly paler (elytral colour of Dorrigo and Macksville males is moderately dark brown with pale interstitial lines and margins, similar to *A. flammans*; head and antennae red brown; ventral pro and mesothorax pale, metathorax dark brown; legs pale except for dingy brown tibiae and dark brown tarsi; ventral abdomen dark brown except for pale cream sternites 6, 7; dorsal abdomen very dark brown - black except for pale tergite 8 and sometimes pale posterior margin of tergite 7.

Pronotum 2.2-2.6mm wide; 1.2-1.4mm long; W/L 2.0 (lectotype); midanterior margin often pointed, lateral margins divergent posteriorly; anterolateral and lateral margins often somewhat reflexed; punctures broad, shallow, broader in lateral areas, all contiguous. Elytra parallel-sided when closed, with 4 well-defined interstitial lines.

Head covered by pronotum at rest; moderately depressed between eyes, GHW 1.2 -1.4mm; SIW 0.2mm; ASD < ASW; frons scarce, 1 × ASW, frons-vertex junction rounded; mouthparts very small, non-functional; apical segment of labial palpi fusiform. Antennal length subequal to GHW; with FS 1 slightly longer than scape, FS 2-9 shorter than FS1 and subequal.

Light organs occupying sternites 6, 7 entirely, or posterior margin of 7 very narrowly clear; MPP of sternite 7 gently produced and apically rounded; tergite 8 with lateral margins converging slightly posteriorly, median posterior margin rounded and projecting a little beyond the rounded posterolateral corners. Aedeagus (Fig. 5P-R) L/W 2.0; basal piece not hood like; ML scarcely wider at level of EO than at apex; LL divergent along their length dorsally; apices slightly bulbous but not divergent when viewed from below; hairs restricted to apical 1/3 or less.

Female. 5.7-7.2mm long; with fully developed elytra and hind wings about 2/3 as long as elytra (abdomen may protrude beyond elytral apices). Dorsal body dingy cream; pronotum with median irregular brown marking; head brown, antennae dingy cream; ventral thorax and abdomen cream.

Pronotal outline similar to that of male, anterior and posterior margins sometimes indented in the midline; punctures contiguous. Elytra fully developed, slightly convex-sided when closed; with 4 well defined interstitial lines, and either covering abdomen completely at rest or at most with 2 segments protruding. Head very small, form of wingless female; very slightly excavated between the widely separated eyes; mouthpart complex small but could be functional. Abdomen with median posterior margin of sternites 7 and 8 shallowly indented.

Larva. (Fig. 15B). Lateral margins of terga 1-10 slightly ridged, finely hairy and densely spinose; median line from anterior margin of tergum 1 to posterior margin of tergum 11 slightly elevated and bordered with hairs and small spines; punctures in anterior half of terga 2-10 not any larger than rest. Protergum 1.5-1.9mm long, 2.2-2.7mm wide; anterior margin in median and anterolateral areas indented; tubercles lacking;

posterolateral corners of protergum and terga 2-11, rounded. Posterolateral corners of tergum 12 projecting slightly. Head 1.2-1.5mm long, 1.2-1.7mm wide; broadly excavated along anterior margin (Fig 7Q).

Dorsally yellowish with dark brown markings; protergum cream with narrow dark brown margin and dark areas in posterior half; meso and metaterga very dark brown, with paired paler areas at antero- and posterolateral angles, and along posterior margin to either side of midline, or median area of tergum 3 and abdominal terga 4-9 with broad paler areas; lateral pale areas on terga 4-9 may almost coalesce, and median cream areas on at least terga 4, 5 may extend from anterior to posterior margins; terga 10, 11 largely cream, with narrow dark brown markings to either side of midline; if terga 10, 11 are mainly cream then tergum 12 is also pale; if terga 10, 11 have extensive light brown markings then tergum 12 is similarly marked; dorsum of head mostly dark brown with irregular pale areas behind ocelli; legs, and all ventral thoracic plates, dark brown; abdominal segments 4-9 with dark brown sterna with a narrow median pale strip, and brown epipleural plates with median pale markings; ventral segments 10-12 pale cream except for dark brown anterior margins of epipleural plates of segment 10.

DISTRIBUTION. Apart from two S Qld records from the Conondale Ra., this species is restricted to northeast and central NSW where some records are from rainforest (Fig. 14).

REMARKS. This species has the most southern distribution of any Australian firefly and is popularly known as the 'Blue Mountains firefly'. Olliff (1890) described a light display at Mount Wilson. Lea (1929) recorded 6 males of *A. lychnus* from Mount Tamborine, Qld. The four males relocated at QM are *Atyphella similis* described here as new. A lectotype is designated to resolve this confusion. Figures of the ventral surface of the male in Lawrence & Britton (1991: fig. 35.38D, reproduced in Calder [1998: 172]) show two small unlabelled projections beyond the posterior margin of abdominal sternite 7; they are probably the aedeagal sheath and the tip of the aedeagus.

Atyphella majuscula (Lea)
(Figs 3, 5, 12)

Luciola majuscula Lea, 1915: 495.
Luciola (Luciola) majuscula Lea. McDermott, 1966: 109.
Atyphella majuscula (Lea) comb. nov. Ballantyne in Calder, 1998: 177.

TYPE. Lectotype.♂ (dissected) N Qld: Cape York Pen., 13.57S, 143.12E, Coen Dist., HH, 12727 (SAM). Calder (1998) regarded this single♂ as the only syntype remaining of the original material.

MATERIAL. Syntype ♂ and 78 specimens. N QLD: 12.44S, 143.14E, 3km ENE of Mt Tozer, 1-4.vii.1986, TW, ANIC berlesate 1052, RF litter, 2 larvae (ANIC). 12.44S, 143.17E, Iron Ra., 3.i.1972, PZ, 3♂ (ANIC, AM); 6.v.1968, GBM 7 larvae (UQ). 12.44S, 143.15E, W Claudie R, 4km SW of road junction, 6.xii.1986, G. Daniels, M. Schneider, 2♂ (UQ). Claudie R nr Iron Ra., 19-25.vii.1978, JL, berlesate 648, 1 larva (ANIC). Claudie R nr Mt Lamond, 8♂, 1♀, 1-5.i.1972, DKM & Holloway (AM). Iron Ra., S slope of Mt Lamond, 13.vi.1971, R. Taylor & J. Freeman, ANIC berlesate 314, RF, 2 larvae (ANIC). 13.49S, 143.28E, Rocky R, Silver Plains, E coast: 6.i.1960, JLW, 5♂ (ANIC), 5♂, 1♀ (2♂, 1♀T. 22, 25 UQ); 14.xii.1964, JLW, GBM, LP, 11♂, 1♀, (4♂, 1♀, T.117); 15.xii.1964, JLW, GBM, LP, 15♂, 1 larva (3♂, 1 larva T. 116, 119; 2♂ QM); 16.xii.1964, JLW, GBM, LP, 8♂, 1♀(1♂, 1♀ T.118 UQ). 13.52S, 142.51E, Coen R, W. Dodd, 1♀(SAM).

DIAGNOSIS. Males large (10.7-13.4mm long); pronotum orange, lacking any darker markings, elytra dark brown, with 3 well defined interstitial lines; elytra slightly convex sided when closed; antennal sockets not contiguous; mouthparts well developed; frons-vertex junction not defined. Females macropterous, coloured as for male.

DESCRIPTION. Males are redescribed; females and larvae are newly described.

Male. 10.7-13.4mm long; pronotum, MS and MN light orange; elytra dark brown; head and antennae dark brown; ventral thorax orange; legs orange except for dark brown apical 1/2 of femora and dark brown tibiae and tarsi; ventral abdomen dark brown except for pale cream sternites 6, 7; dorsal abdomen dark brown except for pale tergites 7, 8.

Pronotum 3.4-5.8mm wide; 2.0-2.7mm long; W/L 1.7; midanterior margin rounded, little if at all produced beyond rounded anterolateral corners; lateral margins diverge posteriorly in anterior half then may converge slightly; pronotal punctures broad, shallow, contiguous. Elytra slightly convex-sided when closed, with interstitial lines 1, 2, 3, well defined, and 4 ill defined.

Head not completely covered by pronotum at rest, moderately depressed between eyes; GHW 2.2-2.9mm; SIW 0.3-0.5mm; ASD subequal to ASW; frons not clearly delimited or separate from vertex, frons-vertex junction not defined; mouthparts well developed; apical segment of labial palpi flattened and dentate. Antennal length > GHW but < 2 × GHW; FS subequal in

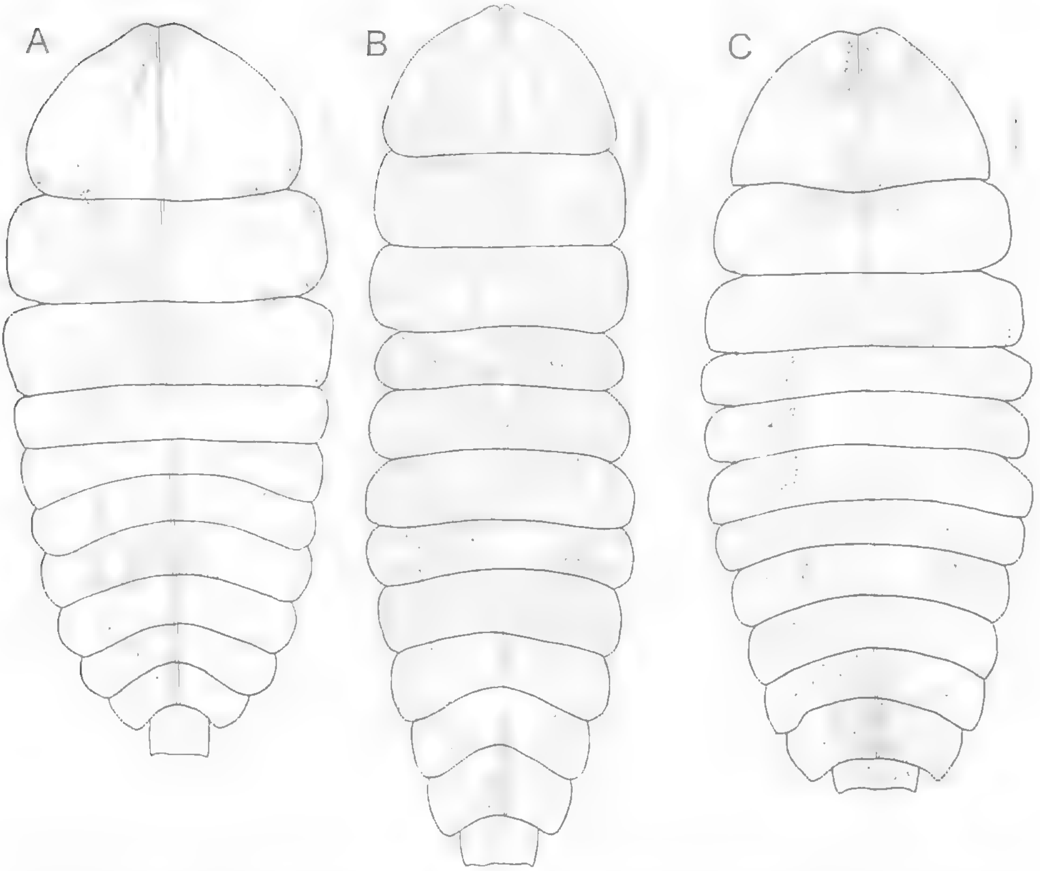


FIG. 12. *Atyphella* larvae, dorsal aspects. A, *A. flammans* (left and right sides represent different colour patterns); B, *A. similis*; C, *A. majuscula*. Scale lines 1mm.

length, longer than wide and slightly shorter than scape.

Light organs (Fig. 3J) occupying sternites 6, 7 except for narrow posterior margin of 7; MPP of sternite 7 moderately produced and apically rounded; tergite 7 (Fig. 3K,L) with lateral margins converging posteriorly; tergite 8 much narrower than 7, lateral margins converging strongly posteriorly, and median posterior margin straight; ventral surface of tergite 8 with 2 slightly sclerotised lateral longitudinal lines. Aedeagus (Fig. 5A-C) L/W 3.5; basal piece large, with anterior margin projecting conspicuously dorsally and appearing hood-like in lateral aspect; ML elongate, slender, not expanded at EO or at apex; LL approximate dorsally, very broad in lateral aspect, diverging only at their apices which are narrow; hairs borne preapically along slightly less than 1/3 of length of LL.

Female. 12mm long. Macropterous and capable of flight. Coloured as for male, except for pale light organ in sternite 7, and yellow sternites 8, 9 and tergites 7, 8.

Pronotal outline like that of male except mid-anterior margin not produced much beyond anterolateral angles; punctures as for male. Elytra with 3 well defined interstitial lines (1, 2, 3). Head concealed beneath pronotum at rest; barely excavated between the eyes, form of winged female head; GHW 5 × SIW; apical segment of labial palpi flattened and dentate. Light organ (appearing as compact fat body material) restricted to sternite 7 but sternite 8 may have irregularly distributed fat body material; median posterior margins of 8 and 9 indented.

FIG. 13. Records for three species of *Atyphella* in far north Queensland rainforest.

Larva. (Fig. 12C). Lateral margins of terga 1-11 slightly ridged, hairy and spinose; median line from anterior margin of tergum 1 to posterior margin of tergum 11 not elevated or laterally margined; punctures in anterior half of terga 2-11 slightly larger than rest. Protergum 1.3-2.7mm long, 2.2-5mm wide; median anterior margin broadly and shallowly indented; protergum not narrowed in anterior 1/6; lacking tubercles; posterolateral margins of protergum and terga 2-10 acute. Posterolateral corners of terminal abdominal tergum slightly produced. Head about as long as wide; anterior margin emarginate as described for *A. flammans*. Dorsally cream, marked patchily in dark brown; protergum with an anteromedial dark brown area, otherwise patchily dark marked; mesotergum with small dark anterolateral areas; metatergum with lateral oblique dark brown strips, and median area dark brown; abdominal terga 4-11 patchily brown, (tergum 8 darker than rest); tergum 11 with wide pale lateral areas; legs pale brown; ventral thoracic plates faintly marked with light brown; abdominal segments 4-9 with dark epipleural plates (pale around spiracles); sterna of segments 4-9 pale with light brown markings; ventral surface of segments 11, 12 pale.

DISTRIBUTION. Restricted to rainforest in the Iron Ra. and McIlwraith Ra. in central Cape York Peninsula; also recorded from Papua New Guinea (Ballantyne, 1992) (Fig. 8).

REMARKS. Lea (1915) highlighted the large size of this species (it is the largest Australian lampyrid), and the pronotal shape. Ballantyne (1992) recorded it from New Guinea and distinguished the following similarly sized and coloured species: *majuscula* Lea, *guerini* Ballantyne and *salomonis* Olivier.

Atyphella monteithi Ballantyne sp. nov.
(Figs 1, 2, 4)

TYPE. Holotype, ♂, N Qld: 16.51S, 145.43E, Crystal Cascades, via Cairns, 9.xii.1964, GBM (QMT62709).

MATERIAL. Holotype and 2♂ paratypes collected with holotype (UQ).

DIAGNOSIS. Medium size (7.0-8.5mm long); pronotum orange with median dark marking; elytra dark brown with 3 well defined interstitial lines; elytra slightly convex sided when closed; antennal sockets not contiguous; frons-vertex junction rounded. Female and larva not associated.

DESCRIPTION. *Male*. 7-8.5mm long; pronotum dingy orange with median dark brown marking; pronotal punctures margined with deeper orange; MS and MN pale cream; elytra dark brown, suture pale brown in anterior3/4; head and antennae dark brown; labrum pale; ventral surface of pro and mesothorax light brown, of metathorax dark brown; legs 1, 2 pale except for dark brown tibiae and tarsi; legs 3 pale except for dark brown coxae; basal abdominal sternites dark brown, sternites 6, 7 pale cream; dorsal abdomen dark brown except for pale tergite 8.

Pronotum (Fig. 1J) 2.5-3.0mm wide; 1.4-1.6mm long; W/L (holotype) 1.8; midanterior margin gently rounded, scarcely produced beyond anterolateral angles; lateral margins divergent posteriorly in anterior 2/3 and slightly convergent in posterior 1/3 in holotype and one paratype, divergent along almost their entire length in second paratype; punctures broad, shallow, contiguous over all of disc. Elytra with three well defined interstitial lines (1, 2, 4) present; slightly convex-sided when closed; elytral punctures densely clustered along interstitial lines.

Head (Fig. 2A,B) small, concealed beneath pronotum at rest, moderately depressed between eyes; GHW 1.3-1.5mm; SIW 0.15-0.2mm; ASD < ASW; frons high and flat, 2 × ASW; frons-vertex junction rounded; mouthparts well developed; apical segment of labial palpi fusiform. Antennal length subequal to GHW; with FS 1 narrowed basally, about 1.5 × FS 2; FS 5-8 subequal, about as wide as long; FS 9 elongate, slender, 2 × FS 8.

Light organs (Fig. 4C,F) occupying sternites 6 and 7 except for narrow posterior margin of 7; MPP of sternite 7 moderately produced, and bluntly rounded at apex; tergite 8 with lateral margins subparallel and posterior margin rounded. Aedeagus L/W 2.2; basal piece not hood like; ML slightly expanded at level of EO but not expanded at apex; LL moderately divergent along their length dorsally and slightly bulbous at their apices; hairs along apical 1/3 or less.

DISTRIBUTION. Known only from these three specimens netted while flying and flashing at night in rainforest near Cairns (Fig. 13).

REMARKS. This rare species is named for Geoff Monteith of the QM in grateful appreciation of his continued interest and support in the collection of specimens of fireflies.

Atyphella olivieri Lea

(Figs 1, 2, 3, 5, 15, 36A)

Atyphella olivieri Lea, 1915: 494; 1921a: 197; 1921c: 7. Ballantyne in Calder, 1998: 177 (comb. rev.).

Atyphella Olivieri Lea. Olivier 1910: 47; 1911a: 172.

Luciola (Luciola) oliveris (Lea). McDermott, 1964: 16. Unn. nom. nov.

Luciola (Luciola) olivierius (Lea). McDermott, 1966: 110. Unnecessary name change or probable misspelling for *L. oliveris* McDermott 1964.

TYPE. Lectotype. ♂ (designated here). N Qld: 16.55S, 145.46E, Cairns (QM). The lectotype is the upper specimen of 2 syntypes mounted on card and labelled 1. C/2253; 2. COTYPE; 3. hand-written label '*Atyphella olivieri* Lea Queensland'; 'cotype' in red ink. Paralectotypes, same locality as lectotype, 34 'syntype' ♂ (AM, 6; ANIC, 6; UQ 2; SAM 8; MV, 8; QM, 2; BMNH, 2).

MATERIAL. Lectotype, paralectotypes and 267 specimens. Larval specimens # have a small dorsal elevation in the median area of pronotum 1/4 length behind the anterior margin. N Qld: 15.42S, 145.13E, Mt Finnigan summit, via Helenvale, 28-30.xi.1985, 1100m, GBM, DC, Roberts, 1♂ (QM). 15.43S, 145.17E, Big Tableland, ANZSES exp., 19-20.xii.1990 1♂. 15.48S, 145.15E, Shipton's Flat, 35km S of Cooktown, 22.iv.1982, GBM, DY, GT, 1♂. 15.50S, 145.19E, 2km NE of Mt McMillan, 500-800m, ANZSES exp., 11-13.i.1991, 2♂. 16.05S, 145.29E, Cape Tribulation, 22 ix-7.x.1982, GBM, DY, GT, 2♂. 16.03 S to 16.05S, 145.28E, Cape Tribulation area, 21-28.iii.1984, A. Calder, TW, 5♂; berlesate 939 lowland RF, 5 larvae (ANIC); 14.vii.1982, S. & J. Peck, RF leaf litter, 1 larva #. 16.12S, 145.26E, Alexandra Bay, 24.vi.1971, R. Taylor, < 50 m, ANIC berlesate 331, RF, 1 larva. 16.14S, 145.26E, Thornton Ra., 23.vi.1971, 100m, R. Taylor, ANIC berlesate 325, RF, 1 larva #. 16.28S, 145.19E, Rex Ck 5km W of Mossman, 21.iv.1997, RF night collection, C.B. & C. Pavey, 1♂ (QM). 16.28S, 145.23E, 3mi. W of Mossman, IC & MU, 25♂ 14.iii.1964, 18♂ 17.iv.1964 (ANIC). Mossman Gorge, in RF, at light, 29.x.1966, EB, 1♂. 16.37S, 145.20E, Rifle Ck, at Black Mt., 18km ESE of Julatten, 13-14. iv. 1982, in RF, 400 m, GBM, DY, DC, 1♂ (QM). 16.49S, 145.38E, Kuranda, 1♂ (CAS); 3♂ (2♂ iv.1905), F. Dodd (SAM; one♂ bears label 'descd as var of *flammans*'); 8.iii.1966, D. Havenstein, 1♂ (ANIC); 1 mi. E of Kuranda, 19.iv.1964, IC, MU, 3♂. Nr Barron Falls, Kuranda, Stop A34, 15.iii.1988, D. Rentz, 1♂. 16.55S, 145.40E, Mt Williams summit, 1000m, 27-28.xi.1997, GBM, DC, 3♂; 27.xi.1997-6.ii.1998, RF FIT, 1♂ (QM). 16.55S, 145.46E, Cairns, 26.ii.1939, GB, 6♂ (ANIC); Cairns district, F. Dodd, 1♂ (SAM); J. Anderson, 2♂ (QM). Crystal Cascades, via Cairns, 9.xii.1964, GBM, 3♂ (T.123 UQ). Boar Pocket Road, c. 8km N of Gillies Hwy, 21.ii.1970 at light, GB, 2♂ (ANIC). 17.02S, 145.38E, Lamb's Head, 10km W of Edmonton, 12-13.xii.1988, 1200m, GBM, GT, 1♂ (QM); 8-9.i.1990, 1200m, GBM, SRM, 1♀. 17.02S, 145.37E, Davies Ck (15 road km from Kennedy Hwy), 21km E by S of Mareeba, 1.iii.1988, D. Rentz, stop A28, 13♂ (ANIC). 17.06S, 145.36E, Kauri Ck, Lamb Ra., RF, 1190m, 27.xi.1998, GBM, P. Bouchard, A. O'Toole, 1♂ (QM). 17.06S, 145.37E, Mt Haig Rd, 11km NE of Tinaroo Dam, Atherton Tbld, Stop A15, 5.ii.1988, D. Rentz, 1♂ (ANIC). 17.07S, 145.41E, Little Mulgrave R, HH, 1♂ (QM), 2♂ (SAM), 6♂ (CAS). 17.15S, 145.38E, Lake Barrine, Atherton Tbld, 29.i.1988, Stop A-8, D. Rentz, 2♂ (ANIC). 17.16S, 145.29E, 4mi. S of Atherton, 16.ii.1975, H. & A. Howden, 1♂. 3.2km N of Atherton, 5.v.1970, ANIC berlesate 275, RF, 2 larvae. Ringrose NP, via Atherton, 9.xii.1966, BC, 2♂,

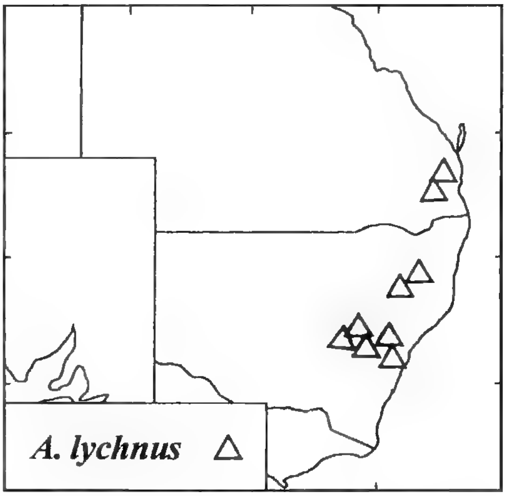


FIG. 14. Records of *Atyphella lychnus* in southeast Australia.

taken with *A. brevis* (UQ). Mt Edith, 18 mi. NE of Atherton, 3400 ft., 18.iii.1964, IC, MU, 1♂ (ANIC). Tolga Scrub, nr Atherton, 28.xi.1964, R. Elder, 5♂ (UQ). 17.17S,145.34E, Curtain Fig, 2km SSW of Yungaburra, Atherton Tbld, Stop A2, ii.1988, D. Rentz, 1♂ (ANIC). 17.17S,145.58E, Graham Ra., 550m, 8-9.xii.1995, GBM, 14♂, 1♀ (QM). 17.17S,145.34E, Curtain Fig, 2km SSW of Yungaburra, Atherton Tbld, 2.ii.1988, Stop A-2, D. Rentz, 1♂ (ANIC). 17.21S,145.46E, Tolga, 5.i.1984, R. Lachlan, 4♂ (AM). 17.23S,145.23E The Crater nr Herberton, xii.1961, DKM, 12♂, 1♀. 17.31S,145.37E, Millaa Millaa Falls, via Millaa Millaa, GBM, 9.i.1964, 1♂ taken with *A brevis* (T.26 UQ), 5.xii.1965, 10♂ (T.196); 10-11.xii.1966, BC, 13♂; 16.iv.1997, GBM, Russell, Ovenden, 1♂ (QM). 17.32S,146.01E, Innisfail, J. Gilchrist, xii.1963, 6♂ (T.5 UQ), 1♂ i.1964 (T.28); 4♂ (ANIC); 3♂ (MV). 17.33S,145.31E, Chilverton, 22.xii.1964, H. Rose, 1♀ (T.124 UQ). 17.36S,145.45E, Henrietta Ck, Palmerston NP, GBM, 6.xii.1965, 2♂, 1 larva (2♂ T.184, 1 larva T.195 UQ), 23.iv.1970, 3♂, 29.xii.1964, 9♂ (T.129), 12.xii.1966, BC, 3♂. 17.46S,145.35E, Cardstone, via Tully Falls, 10.v.1983, 200m, GBM, DY, 1♂ (QM). 17.50S,145.36E, Tully R crossing, 10km S of Koombooloomba dam, 4-5.i.1990, 750m, GBM, SRM, 3♂. Cardwell Ra., Mt Macalister, 800-900m, 13-16.i.1987, SH, 4♂. Kirrama Ra., Douglas Ck Rd, 800m, 9-12.xii.1986, GBM, GT, SH, 8♂. 17.54S,145.41E, Mt Kooroomool summit, 7km S, 1050m, RF, 3-4.xii.1998, GBM, DC, P Bouchard, 2♂. 18.59S,146.09E, Star Valley lookout, 3km W of Paluma, 13.i.1970, at light, EB, Misko, 2♂ (ANIC). 19.00S,146.12E, Mt. Spec, 1.1966, GB, 6♂. Mt Spec, via Paluma, 8.xii.1965, GBM, 1♂ (UQ); 17.xii.1966, BC, 5♂ (UQ). 19.05S,146.20E, Paluma, 7.xii.1964, LP & GBM, 22♂, 1♀, 3 larvae (T.122), 17.i.1970, in RF, EB, 2♂ (ANIC). Ewan Road, Paluma, 9.i.1968, GB, 1♂. Paluma, Mt Spec, at light, 5.i.1966, GB, 11♂. Paluma Dam, 26.xii.1963, GBM, 24♂ (3♂ T.6, UQ); 30-31.xii.1964, GBM, 1 larva (T.131). Birthday Ck, via Paluma, 4.i.1973, BC, 1♂.

DIAGNOSIS. Male small to medium sized (5.5-10mm long); pronotum very pale cream with median dark marking; elytra dark brown, with interstitial lines 2, 3 and 4 dark brown, and broad pale cream lateral, apical and sutural borders; elytra slightly convex sided when closed; antennal sockets very close; frons-vertex junction not defined. Female macropterous, coloured as for male. Presumed larva with lateral tergal margins ridged.

DESCRIPTION. Males are redescribed; females and larvae are newly described.

Male. 5.5-10.0mm long (lectotype 8.7mm long); pronotum pale cream with median dark brown marking (Fig. 1F); anterior margin of pronotum to either side of midline may be narrowly dark; MS and MN pale; elytra very dark, almost black, with a broad marginal pale cream band extending around elytra except across base; in older specimens the dark elytral colour is restricted, either to an area wholly contained within the dark interstitial lines 1-3, or contained between dark interstitial lines 2-3, with a basal and apical brown area between lines 1, 2 and the intervening area pale blotchy brown, or restricted to the basal 1/8 of elytra, where the interstitial lines are also dark, and the remainder of the elytron including the interstitial lines is pale; interstitial lines 1-3 wholly within dark area, 4 wholly within the lateral cream margin; ventral pronotum dark margined around head cavity; head, antennae and palpi dark brown; frons may be paler than rest; apical segments of maxillary and labial palpi may be pale on their inner margins; ventral pro and mesothorax pale marked with brown, metathorax entirely dark brown; legs dark brown except for pale trochanters, and sometimes pale coxae 2; abdomen black except for pale sternites 6, 7 and tergite 8, and pale tergite 7 with brown markings (Fig. 3F,I).

Pronotum (Fig. 1F) 2.3-3.0mm wide; 1.3-1.7mm long; W/L (lectotype) 2.0; midanterior margin sometimes ridge like, moderately produced beyond anterolateral angles; mid-anterolateral margin may be slightly indented; lateral margins divergent posteriorly; punctures broad, shallow, contiguous. Elytra slightly convex-sided when closed; with 4 well defined interstitial lines, of which 1 is the longest, and 4 usually the shortest; lines 1, 2 sometimes sub-equal in length and almost as long as 4.

Head (Fig. 2H) not completely covered by pronotum at rest, deeply depressed between eyes; GHW 1.4-2.0mm; SIW 0.2-0.3mm; antennal sockets contiguous or nearly so; frons 1 × ASW, sloping gently to vertex, no defined frons-vertex junction; mouthparts small; apical segment of labial palpi flattened and dentate. Antennal length slightly > GHW; FS 1, 2 subequal, and slightly longer than remainder; FS 3-5 subequal in length, and broader than FS 6-8, which are subequal in length; FS 9 elongate slender, about 1.5 × FS 8.

Light organs occupying sternites 6 and 7 entirely (Fig. 3F,I); MPP of sternite 7 barely produced and gently rounded; tergite 8 with lateral margins subparallel, median posterior margin rounded and projecting a little beyond the rounded posterolateral corners. Aedeagus (Fig. 5D-F) L/W 3; basal piece not hood like; ML not bulbous around ejaculatory orifice or apex; LL sub parallel sided, narrowing slightly in apical

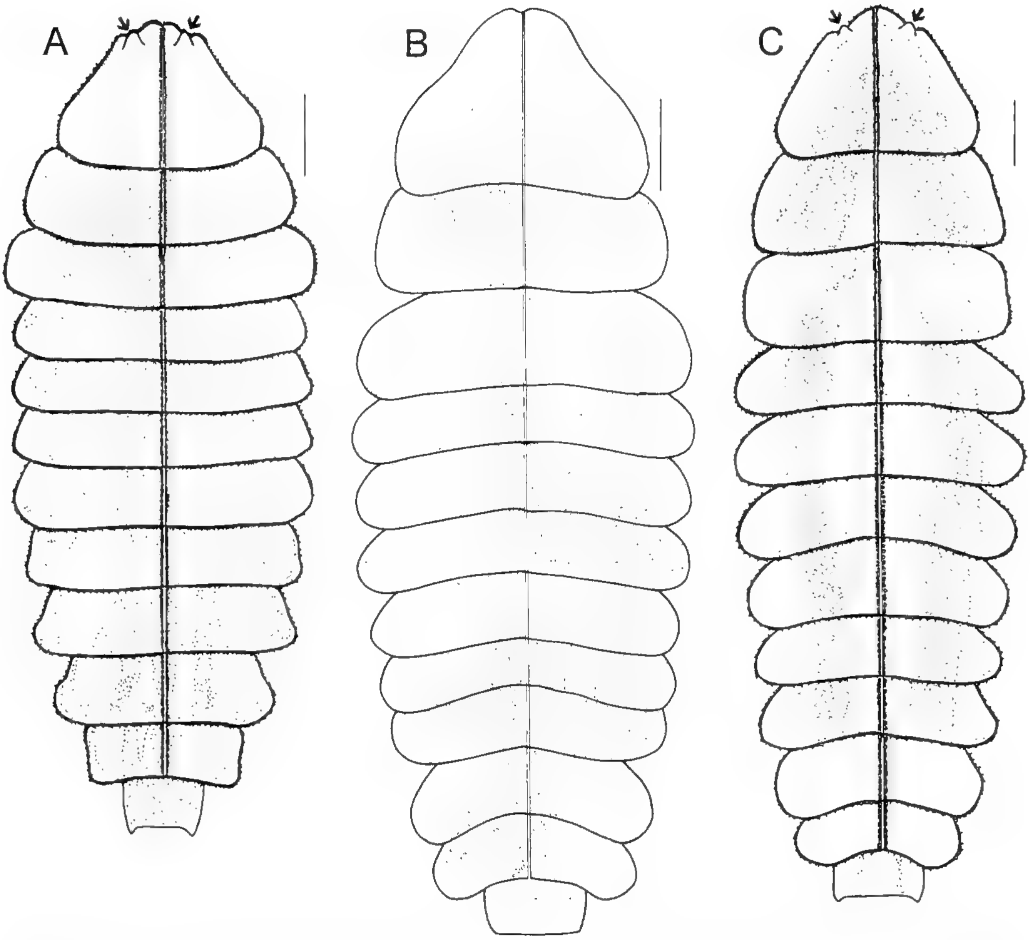


FIG. 15. *Atyphella* larvae, dorsal aspects. A, *A. olivieri*; B, *A. lychnus* (left and right sides represent different colour patterns); C, *A. scintillans*. Arrows indicate pronotal tubercles. Scale lines 1mm.

1/3, and gently diverging at apex; hairs borne in apical 1/3 or less.

Female. 6.5-8.0mm long; elytra fully developed but not covering gravid abdomen and at least 3 sternites may protrude beyond tips of elytra; hind wings almost as long as elytra, and gravid female may not be capable of flight. Coloured as for male with these exceptions: all legs light brown; ventral thorax cream with extensive light brown markings; abdomen pale cream with pale light organ in sternite 7.

Pronotal outline like that of male except midanterior margin narrowly indented, and midposterior margin broadly and shallowly indented. Head of winged female head form; with small mouthparts; GHW 2-2.5 × SIW; slightly depressed between the eyes. Abdomen with median posterior margins of sternites 7 and narrowly indented.

Larva. Larvae not reliably associated; taken at the same time as numerous flying males (LB, pers. obs.) (Fig. 15).

All terga with lateral margins thickened and all dorsal surfaces including margins bearing numerous minute spines and hairs, especially densely across posterior margins of terga; median line from anterior margin of tergum 1 to posterior margin of tergum 11 elevated and laterally ridged; punctures in anterior half of terga 2-10 not any larger than rest. Protergum midanterior margin indented; specimens # have a small dorsal elevation in the median area 1/4 length of pronotum behind the anterior margin; anterolateral areas of protergum indented and bearing paired rounded tubercles of which one pair projects dorsally and one pair ventrally; posterolateral corners of all terga except 12 rounded; posterolateral corners of 12 projecting slightly. Head broadly and shallowly excavated across anterior margin.

Dorsum yellow, with extensive dark brown markings; protergum yellow with brown lateral margins and midline brown margined; terga 2-8 dark brown with lateral areas cream; terga 10, 11 with extensive cream areas; terminal tergum dark brown; ventral surface cream with extensive dark markings; legs cream to light brown; thoracic epipleural plates dark brown; ventral plates of abdominal sterna 4-9 dark brown, with irregular cream markings on epipleural plates, and a narrow median cream area on sternal plates; epipleural plates of segment 10 margined with brown, remainder of segments 10-12 cream.

DISTRIBUTION. Occurs from sea level to above 1,000m throughout the Wet Tropics zone of N Qld and is one of the few species to occur at Paluma Ra. in the southern sector (Fig. 16).

REMARKS. This easily recognisable species is well represented in collections, flies in large numbers and is easily netted at night (LB, pers. obs.). It is frequently taken with either *A. inconspicua* or *A. brevis*. A living specimen is shown in Fig. 36A. Certain (?older) specimens have paler elytral colouration which has caused them to be identified in collections as *A. flammans*.

Atyphella scintillans Olliff
(Figs 1, 5, 15, 36C)

Atyphella scintillans Olliff, 1890: 650. Lea, 1909: 111; 1921a: 198 (female). Ballantyne in Calder, 1998: 177 (comb. rev.).
Luciola decora Olivier, 1902: 77; 1907: 51; 1910: 47. Lea, 1909: 111 (synonymy).
Luciola (Atyphella) scintillans (Olliff). McDermott, 1964: 44.
Luciola (Luciola) scintillans (Olliff). McDermott, 1966: 112.

TYPE. Lectotype. ♂ (designated here). NSW: Ash I., Upper Hunter R, Scott (specimen on the right of 2 syntypes glued ventral side down on card) (K33980, AM). Paralectotypes, 4♂ labelled as for lectotype (AM, SAM).

MATERIAL. Lectotype, paralectotypes and 231 specimens. SE QLD: 24.32S, 151.23E, Bulburin SF 600m, 9km E of Many Peaks, 17.ix.1989, GBM, 1♂ (QM). 26.51S, 151.34E, Bunya Mtns, x.1919, H. Carter, 1♂, 1♀ (MV); 18-19.xi.1967, GBM, 1♂ (UQ), 1♂ (QM); 21.ii.1965, GBM, 1 larva (T.158, UQ); 3♀ (SAM); 16.x.1973, A. Neboiss, 4♂ (MV); 10.xii.1925, HH, 1♀ (QM); 8.x.1968, flashing at night, T. Houston, 1♂ (SAM). Mt Nebo iv.1984, M. Peterson, 1♂ (ANIC). Moss' Well, Spicer's Gap, 13-14.x.1984, R. de Keyser, 3♂. 27.28S, 153.01E, Brisbane, May, 1959, 2 larvae, E. Bernays (T.37 UQ); 1.v.1961, 1♂, 9.iv.1960, 1♂, K. Korboot; 5.ix.1962, E. Bernays, 1♂; 20.ix.1962, 2♂ B. Wilson; 20.xi.1963, P. Shepherd, 1♂; 5.x.1973, A. Burrows, 1♂. Brisbane, University Mine site at Indooroopilly, LP, ix-x.1962, 4♂, 2♀, 4 larvae (2♂, 1♀ T.34, 1♀ T.35, 4 larvae T. 38,39). 27.20S, 152.46E, Mt Glorious, 24.ix.1963, GBM 2 larvae (T. 85,86); 16.viii.1964, TW, 1 larva (T.90); 14.x.1994, K. Hiller, 4♂, 1♀ (QM). Mt. Glorious, Maiala NP, in lantana, 6.30 p.m., 20.ix.1964, LP, 2♀ (both had laid eggs before preservation, T.97 UQ). Highvale, 5.x.1963, A. French, 1♂. 27.30S, 152.55E, Brookfield, 20.ix.1964, 1♂ (T.89). 27.91S, 153.16E, Mt Tamborine, Joalah NP, 23.vii.1979, JL, ANIC berlesate 656 flood debris and leaf litter, 2 larvae

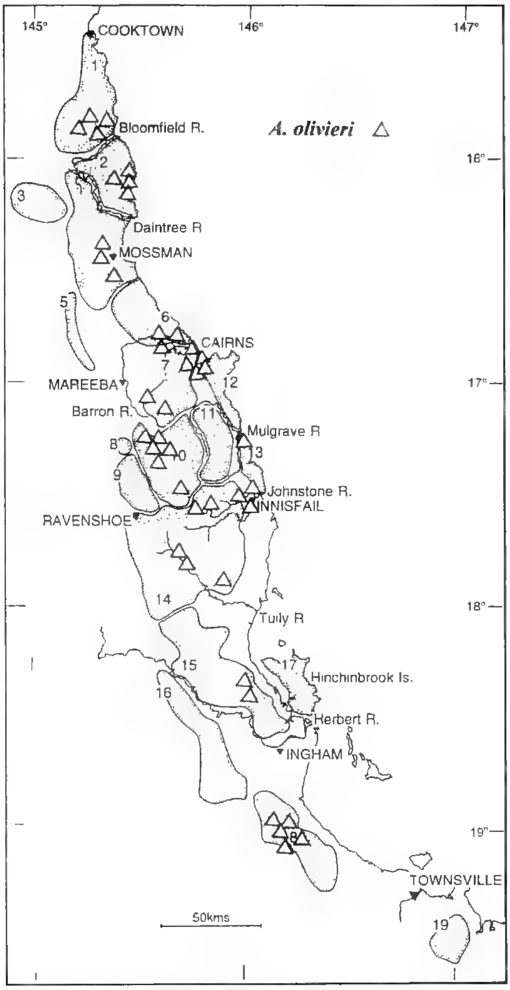


FIG. 16. Records of *Atyphella olivieri* in far north Queensland rainforest.

(ANIC). 28.03S, 152.24E, Cunningham's Gap NP, 26.xi.1964, LP, 8♂, 1♀(5♂, 1♀ T.155, UQ); 30. xi.1963, in leaf mould, GBM, 1 larva (T.36); 26.xi.1964, H. Rose, 1♂; 12.vi.1961, J. Barrett, 1 larva, (T.65); 1953, GB, 4♂ (ANIC). 28.05S, 153.27E, Burleigh Heads NP, 1961, A. Hiley, 1♂ (UQ); 29.vii.1961, LP, 1♂ (T.64); 20.xii.1963, LP, 7 larvae (T.33); vii.1961, R. Winks, 1♂; 3.ix.1940, HH, 2♂ (BMNH), 2♂ (QM). 28.19S, 153.05E, Lamington NP 19.ii.1961, N. Heather, 1♂ (UQ); 22.v.1962, J. Ferguson, 1♂; 25.v.1962, A. May, 1♂; 11.x.1959, I. Yeo, 2♂; xii.1921, HH, 2 larvae (Lea 1929 tentatively identified these as *A. brevis*); 25-26.x.1923, HH, 19♂ (QM); xii.1921 HH, 2 larvae (identified by Lea 1929: 345 as possible *A. brevis*); 2km N of O'Reilly's, in RF in showery but warm weather, 31.xii.1982, P. Harris, 2♀ (T.255 UQ). Cedar Ck, 28.ix.1930, HH, 7♂ (QM). 28.33S, 152.36E, Queen Mary Falls, Killarney, 12.x.1973, A. Neboiss, 1♂ (MV). NSW: 28.10S, 153.33E, Tweed Heads, J. Follent, 1.ix.1949, 1♂ (QM). 28.10S, 152.36E, 20kms NE of Legume, flying at night, 5.xi.1981, S. Barker, 10♂ (SAM). 28.28S, 152.33E, Tooloom Plat, via Urbenville, 31.x.1970, GBM, 12♂ (UQ); 29-30.x.1982, GBM, 2♂ (QM). 28.27S, 152.45E, Unumgar SF, 580m nr Grevillea, Cox's Road 789, 2-11.i.1987, A. Newton, M. Thayer, subtropical RF, FMHD # 87-177 berlesate, leaf and log litter, 2 larvae (ANIC). 28.40S, 152.21E, Clarence R, 3♂ (MM); ix.1904, H. Carter, 4♂ (MV). Upper Clarence R, ix.1904, H. Carter, 2♂. 28.50S, 153.26E, Victoria Park, via Alstonville, 1.xi.1970, GBM, 1♂ (UQ). 30.64S, 153.01E, Nambucca Heads, 8.ix.1966, G. Condon, 1♂ (AM). 31.35S, 152.36E, junction of Myrtle Rock Road and Compartment 81, Kerewong SF, E of Comboyne, 17.x.1979, stop 39, D. & B. Rentz, 1♂ (ANIC). 32.04S, 151.41E, Gloucester R., Barrington Tops NP, 12-14.xi.1981, TW, 7♂. Barrington House via Salisbury, 26-28.xii.1965, BC, 1 larva. 32.06S, 151.29E, Upper Williams R, Lea, Wilson, 19♂, x.1926 (SAM), 3♂ (UQ), 2♂ (MM); 4♂ (ANIC); 5♂ (MV). William's R, x.1925, H. Carter, 3♂ (ANIC). nr Cutter's Pass, William's R, A. Musgrave, T. Campbell, 23-30.x.1926, 10♂ (AM). 32.08S, 151.27E, Allyn R nr Chichester SF, 10-11.xi.1981, TW, 1♂ (ANIC). 32.13S, 151.34E, Barrington House, via Salisbury, 26-28.xii.1965, BC, 8 larvae (T.192 UQ). Salisbury, 1-5.xi.1957, F. Perkins, 3♂. Barrington, E. Davies, 2♂ (MV). Acacia Plat, 20.xi.1955, J. Sedlacek, 1♂ (UQ), 2♂ (BPBM). 32.13S, 152.51E, Forster, 29.ix.1993, A. Rose, 3♂ (AM). 32.15S, 151.20E, Tuglo Wildlife Refuge, 17.xi.1985, B. Day, 1♂. 32.17S, 152.50E, Cape Hawk, C. Burett, 2♂ (MV). 34.54S, 150.00E, Wilson Park, 50m, 3km SE of Lismore, S. & J. Peck, dry RF litter, 2 larvae (ANIC).

DIAGNOSIS. Male medium sized (6.6-9.9mm long); pronotum cream with median dark marking; elytra black with 4 well defined interstitial lines; elytra parallel-sided when closed; antennal sockets not contiguous; frons-vertex junction convex. Female with greatly shortened elytra which are contiguous in the mid line, and vestigial hind wings; dorsally cream except for median brown marking on pronotum. Larva (Fig. 15) dorsally brown, marked in dark brown, black, and yellow.

DESCRIPTION. Males and females are redescribed; larvae are newly described.

Male. 6.6-9.9mm long (lectotype 8.5mm); pronotum cream with median dark markings; MS brown, anterolateral corners sometimes pale; MN cream; elytra very dark brown; head and antennae very dark brown; ventral prothorax cream, mesothorax cream with brown markings, and metathorax dark brown with lateral margins pale; legs 1, 2 cream with dark tibiae and tarsi; legs 3 cream with coxae, tibiae and tarsi dark brown; abdominal sternites black except for cream 6, 7; tergites 2-5 dark brown, 6 and 7 light brown (Bulburin male in QM has 6 and 7 dark brown); 8 pale cream.

Pronotum (Fig. 1C) 2.1-3.4mm wide; 1.3-1.7mm long; W/L (lectotype) 1.6; midanterior margin bluntly pointed; lateral margins diverging posteriorly; punctures small, not contiguous over centre of disc, larger and contiguous in lateral and postero-median area. Elytra parallel-sided when closed; with 4 well-defined interstitial lines.

Head concealed beneath pronotum at rest; deeply depressed between eyes; GHW 1.4-2.0mm; SIW 0.25mm; ASD subequal to or > ASW; scarce frons, about 1 × ASW, frons-vertex junction well defined, convex; mouthparts well developed; apical segment of labial palpi fusiform. Antennae apparently 9 segmented, (10 segmented in Bulburin male in QM); antennal length slightly < GHW; FS 1 1.5 × FS 2, and acutely narrowed basally; FS 3-5 subequal, and slightly shorter than 1, 2.

Light organs occupying sternites 6, 7 except for a narrow posterior margin of 7; MPP of sternite 7 slightly produced; lateral margins of tergite 8 subparallel, median posterior margin rounded and projecting a little beyond posterolateral corners. Aedeagus (Fig. 5V,W) L/W 1.7 (lectotype); ML moderately expanded around ejaculatory orifice, scarcely expanded at apex; LL subparallel to slightly convex along lateral margins, divergent along their length dorsally, bulbous at apices.

Female. 5.5-11.0mm long; brachelytral, hind wings present as narrow vestiges. Dorsal body pale cream except for dark median markings on pronotum, and light brown elytra; head, antennae and palpi light brown; light organ in sternite 7 waxy white.

Pronotal outline like that of male. Elytra 1.5 × as long as median length of pronotum, contiguous in midline, and with 4 moderately well defined interstitial lines present. Head of wingless female form; GHW 2-3 × SIW; shallowly depressed between eyes; antennae 9 segmented. Abdomen with median posterior margins of sternites 8 and 9 narrowly emarginate.

Larva. (Fig. 15C). Lateral margins of terga 1-11 moderately strongly ridged and clothed with short hairs and short stout spines; median line from anterior margin of tergum 1 to posterior margin of tergum 10 bordered by large elevated punctures; punctures across anterior median fifth of terga 2-11 much larger than rest. Protergum 1.0-2.0mm long, 1.7-3.0mm wide; median anterior margin slightly indented; tubercles present, dorsal pair more strongly developed than ventral pair; posterolateral corners of protergum and terga 2-11 rounded. Posterolateral corners of tergum 12 scarcely produced. Median anterior margin of head broadly and shallowly indented (Fig. 7O).

Dorsally brown-very dark brown and yellow; protergum cream, margined with brown, and extensively marked in brown in posterior half; terga 2-5 similarly marked, mostly brown, with broad very dark bands extending from anterior to posterior margins and narrowly yellow immediately outside these dark bands; thoracic terga 2, 3 usually darker than abdominal terga; abdominal terga 8, 9 may be darker than preceding terga; terga 10, 11 almost entirely yellow, except for brown margin; tergum 12 dark brown with anterolateral areas cream; ventral body yellow or cream with scattered faintly dark markings.

DISTRIBUTION. SE Qld and NE NSW in rainforest or remnant rainforest, especially in suburban Brisbane; often coastal (Fig. 17).

BIOLOGY. *Atyphella scintillans* has been taken in February, September and November from areas near the Brisbane R in Indooroopilly and Corinda, former rainforest areas then supporting dense lantana. In the 1960s a hill slope behind the University experimental mine at Indooroopilly provided a relatively undisturbed area for studying this species and *Luciola nigra*, which often flew together. The males of *A. scintillans* flew for about an hour just after dusk. Flight time varies according to weather conditions (e.g. very short in September if nights were cold. Adults did not fly after a very windy day). The brachelytral females were only taken on the ground if their slow and regular flashing was recognised. Living males and females are shown in Fig. 36C. Larvae, recognised by their continuous glow, were collected in moister pockets on the ground. The larval light was continuous unless disturbed, then gradually faded to extinction (Powell, 1964).

REMARKS. Olliff (1890) described the antennae of *Atyphella scintillans* as similar to those of *A. lychnus*, except for the larger terminal joint. *A. scintillans* has only 9 antennal segments. Lea (1921a) described the female from specimens taken with males. McDermott (1964: 44) referred to the female as brachelytral and larviform.

Atyphella similis Ballantyne sp. nov.
(Figs 1, 4, 5, 12)

TYPE. Holotype. ♂, S Qld: 28.19S, 153.05E, Lamington NP at Binna Burra Lodge, 2-3.xii.1965, S. Curtis and LP (QMT T62936).

MATERIAL. Holotype and 509 paratypes. SE QLD: same data as holotype, 197♂ (UQ); v.1962, LP, 80 larvae (T. 2, 3, 59, 100); 11-24.v.1965, GBM, 8 larvae (T.193); 9.xii.1962, LP, 13♂, 2♀, (2 ♂, 2 ♀ T.1), 4 larvae (ANIC). Lamington NP: 4♂, R. Illidge (UQ); xii.1919, HH, 1♂ (QM); xii. 1921 HH, 2♂ (QM, 2♂, 2 larvae are mounted on one card, id. *A. brevis* by A. Lea; the larvae are *A. scintillans*); 2km N of O'Reillys, 31.xii.1982, P. Harris, 2 females (T.255 UQ); nr O'Reilly's, 4.iii.1980, JL, ANIC berlesate 673 leaf litter, 2 larvae (ANIC). 27.55S, 152.26E, Gatton, 19.ii.1961, A. Hiley, 1♂ (UQ; loc. requires confirmation). 27.91S, 153.16E, Mt Tamborine, 4♂ 20.xi.1925, HH (QM, id as *A. lychnus* by A. Lea); Joalah NP, 23.vii.1979, JL, ANIC berlesate 656 flood debris and leaf litter, 4 larvae (ANIC); 20.x.1978, berlesate 653, litter, JL, TW, 9 larvae. Mt Tamborine, N side nr Curtis Falls, leaf mould in RF, 8.v.1953, T. Woodward, 5 larvae (T.60 UQ). 28.06S, 152.24E. Spicer's Peak summit, 30-31.xii.1993, 1200m, GBM, 1♂ (QM). Lever's Plat via Rathdowney, 4.iv.1966, GBM, 7 larvae (T.162 UQ). 28.28S, 152.70E, Barney, 13.xii.1964, S. Curtis, 7♂ (T.204). NSW: 28.23S, 152.46E, Mt Glennie, 16km E of Woodenbong, 25.xi.1982, sieved litter in RF, 910m, GBM, DY, DC, 1♂ (QM). Mt Glennie, 16km E of Woodenbong, 25.x. 1982-3.ii.1983 Q Mus RF FIT, 910m, 11♂ (QM). 28.24S, 152.40E, Unumgar SF, 430m nr Woodenbong, Pole Bridge Road 788, 2-11.i.1987, A. Newton, M. Thayer, dry RF Araucaria-Eucalyptus, FMHD #87-174 berlesate leaf and log litter, 1 larva (ANIC). 28.31S, 153.17E, Nightcap NP., 700m Googarna Rd 3km N of Mt. Nardi 790, 4.i.1987, A. Newton, M. Thayer, warm temperate RF, FMHD #87-178 berlesate, leaf and log litter, 4 larvae. 28.37S, 152.25E, Tooloom Scrub, 30.xii.1966, GBM, 25♂ (T.209). 28.51S, 152.96E, Wiangaree SF, 1000m, 33km NE of Wiangaree, S. & J. Peck, 24.viii.1982, *Nothofagus* litter, 7 larvae (ANIC); 600m, Sheepstation Ck, 29.ii-3.iii.1980, subtropical RF, 26 larvae; Brindle Ck 740m, berlesate from log and leaf litter, 50 larvae. 29.29S, 152.46E, Toonumbar SF 770m, nr Grevillea, Murray Scrub 794, 6.i.1987, A. Newton, M. Thayer, subtropical RF, FMHD #87-182 berlesate leaf and log litter, 7 larvae (ANIC). 29.36S, 152.11E, Gibraltar Ra., via Glen Innes, 27-19 .xii.1972, in RF, GBM, 3♂ (UQ). 30.20S, 152.34E, Dorrigo, 15.xii.1911, R. Tillyard, 4♂

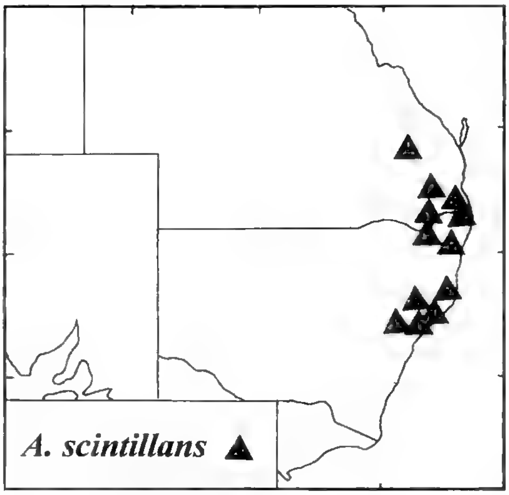


FIG 17. Records for *Atyphella scintillans* in southeast Australia.

(QM); 1♂ (MV, identified as *A. lychnus* by A. M Lea); W. Heron, 3♂ (ANIC). Ulong, E Dorrigo, W. Heron, 2♂ (AM). 30.23S, 152.44E, Dorrigo NP, c. 5km SSE of Dorrigo, 4.i.1971, K. Key, 1♂ (ANIC). Dorrigo NP, Never Never area, Sassafras Ck, wet temperate RF, 750m, 7.xii.1992, D. Bickel, 1♂ (AM). 30.30S, 152.23E, Wright's lookout track, New England NP, 16-18.xi.1990, TW, ANIC berlesate 1131, RF litter under *Nothofagus moorei* and *Dicksonia antarctica*), 5 larvae (ANIC). 30.38S, 152.12E, Styx R SF, 31.xii.1992, V. Lorimer, in detritus, fern tree, 1♂ (AM). 34.54S, 150.00E, Raspberry Rd on Big Hill, 40m E of Armidale, xii.1971, R. Hardie, 4♂ (ANIC).

DIAGNOSIS. Males small to medium (5.8-7.5mm long); pronotum cream with median dark markings; elytra parallel sided when closed, light brown with suture and 3 interstitial lines often paler. Females with very abbreviated elytra not contiguous in the midline, and no hind wings. Confused in collections with *Atyphella lychnus* Olliff and *A. atra* Lea, distinguished by the elytral and terminal abdominal tergite colouration, presence of only 3 elytral interstitial lines in the male, the distance separating the antennal sockets, the brachelytral female and the larval colouration. Very similar to *A. conspicua*, most obviously distinguished by its southern distribution, the width of the antennal sockets, colour of abdominal tergites 7 and 8, and the shape of the frons-vertex junction.

DESCRIPTION. *Male.* 5.8-7.5mm long (holotype 7.3mm long); pronotum cream with dark markings in anteromedial 2/3; MS and MN cream; elytra light brown, suture, lateral margin and interstitial lines often paler; elytra semitransparent and hind wings and body outlines may confuse true colour; head and antennae dark brown; ventral surface of pro and mesothorax pale, of metathorax brown; legs cream except for brown apical one-fifth of femora, and brown tibiae and tarsi; ventral surface of abdomen dark brown except for cream sternites 6 and 7; tergites 2-6 dark brown, 6 brown with cream median area, and 7 & 8 pale, semitransparent.

Pronotum (Fig. 11) 1.7-2.6mm wide; 1.0-1.5mm long; W/L holotype 1.8; midanterior margin slightly acute or rounded, moderately produced beyond anterolateral angles; lateral margins slightly divergent posteriorly; punctures broad, shallow, contiguous over most of disc, punctures in median area of disk smaller, shallower and often separated by 1-2 width of puncture. Elytra parallel-sided when closed, with 3 well-defined interstitial lines (1, 2, and 4).

Head almost concealed beneath pronotum at rest, deeply depressed between the eyes; head between eyes very smooth and shiny; GHW 1.2-1.6mm; SIW 0.2-0.3mm; ASD = half or less than half ASW, never contiguous; frons 2-3 × ASW; frons-vertex junction acute but not elevated in median line; mouthparts moderately well developed; apical segment of labial palpi fusiform. FS1 half as long again as FS2, FS2-3 subequal in length, slightly longer than wide; FS 4-8 subequal in length, about as long as wide, FS 9 apically rounded, one and one-half times as long as FS 8.

Light organs occupying sternites 6 and 7 except for narrow posterior margin of 7; MPP of sternite 7 moderately produced and apically rounded and may be very slightly emarginate; tergite 8 subparallel sided in anterior half (Fig. 4A,D). Aedeagus (Fig. 5S-U) L/W 2.2; basal piece not hood like; ML not expanded at tip nor at level of EO; LL subparallel sided and markedly divergent in apical 1/5; hairs borne in apical 1/3.

Female. 5.5-8.0mm long; brachelytral; hind wings absent. Dorsally pale cream, pronotum dingy cream with median dark markings; elytra very pale brown; head, antennae and palpi light brown; venter of body cream, light organs in sternite 7 white.

Pronotum with midanterior margin rounded, slightly indented in median line; lateral margins slightly divergent in anterior 2/3 and convergent in posterior 1/3; disc scarcely depressed; punctures broad, shallow, some contiguous, some separated by width of puncture; posterolateral corners may be slightly produced. Elytra half as long as pronotum, lacking interstitial lines; sutural margins not touching in repose, not reaching lateral margins of MS in repose. Hind wings absent.

Head of wingless female form; GHW = or slightly < 2 × SIW; ASD > ASW; gently depressed between eyes; frons-vertex junction ridge like.

Median posterior margin of terminal abdominal sternite broadly emarginate, of penultimate sternite entire.

Larva. (Fig. 12B). Lateral margins of terga clothed in fine short hairs and spines, not strongly ridged; median line from anterior margin of tergum 1 to posterior margin of tergum 11 not ridged or margined; punctures in anterior half of terga 2-10 slightly larger than remainder. Protergum 1.1-2.3mm wide; 0.6-1.5mm long; median anterior margin slightly indented; lacking tubercles; posterolateral corners of protergum and thoracic and abdominal terga 4-9 rounded, of terga 10, 11 somewhat acute. Head with median anterior margin broadly and shallowly excavated.

Dorsal colouration cream with brown markings; either dingy cream with faint light mottling; or moderately dark brown , with paler markings; protergum with extensive anterolateral and lateral cream areas; terga 2-9 with pale anterolateral, lateral and posterolateral areas; terga 2-7 with median pale areas; abdominal terga 10 and 11 cream with mottled brown markings; ventral aspect of thorax mainly cream, all plates margined with brown; legs light brown; abdominal epipleural plates 4-9 dark brown, with inner margins cream, and plates 10, 11 cream; median ventral plates of segments 4-7 mainly cream with faint brown markings; abdominal sternum 8 quite extensively brown marked; ventral surface of abdominal segments 10-12 cream.

DISTRIBUTION. SE Qld and NE NSW in high cool mountain areas, mostly in RF; the wide distribution in NSW is based on larval and adult records (Fig. 18). A single record from Gatton is probably a mislabelled student collection.

REMARKS. It was surprising to find large numbers of a new lampyrid species in such a well-collected area as Lamington NP. It is similar to *Atyphella lychnus* Olliff and has been confused with that species, which is known from only two Queensland records. The specific name (Latin, *similis* = like, resembling) emphasises this similarity. The larva illustrated in Lawrence & Britton (1999: 639, fig. 35.391) is probably this species.

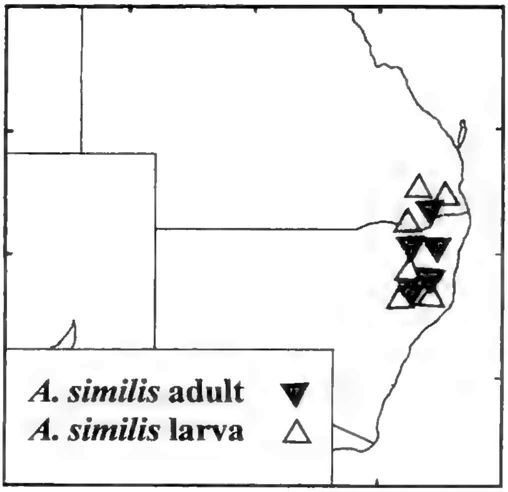


FIG. 18. Records for *Atyphella similis* in southeast Australia.

It was taken at Binna Burra flying in large numbers. Females on the ground were recognised by their slower rhythmic flashing in response to the aerial males. Larvae were taken when their light was sighted.

Luciola Laporte

Calder (1998) gave a full taxonomic history of this genus.

DESCRIPTION. MALE. Dorsal surfaces usually conspicuously punctate and moderately pubescent.

Pronotum. Width/length = 1.2-2.0; midanterior margin rounded, often projecting beyond the rounded, slightly obtuse anterolateral corners; lateral margins narrowly flattened, not more greatly expanded in posterior half in *L. australis, flavicollis, nigra, orapallida*; flattened and expanded more in posterior half in *L. cowleyi*; lateral margins subparallel, or converging a little anteriorly and posteriorly or divergent posteriorly at least in their anterior half, or convergent posteriorly; posterolateral corners approximately right angled, or rounded, obtuse and projecting slightly beyond posterior margin in *L. dejeani;* disc mostly convex, depressed around margin.

Elytra. Punctation not large; conspicuous and similar to that of pronotum; lacking deflexed apex; sub-parallel-sided when closed; at most 3 feebly developed interstitial lines except in *L. cowleyi* where 1, 2 and 4 are well defined; apex of elytron rounded; epipleuron extends past elytral midpoint but not to apex; sutural ridge extends almost to apex except in *L. cowleyi* where it extends only half the length of the elytron.

Head. When viewed from above is moderately to greatly exposed; deeply depressed between the eyes except in *L. dejeani*; posterolateral eye excavation slightly developed to markedly so; GHW 2-6 times SIW; labrum broader than long except in *L. cowleyi* where it is about as long as broad; antennal sockets never contiguous, always separated by at least half ASW; no well defined frontal area or frons-vertex junction; eyes contiguous or nearly so ventrally in *L. cowleyi*, moderately separated in all others. Mouthparts well developed and functional; apical segment of labial palpi fusiform except in *L. dejeani* where it is flattened and dentate. Antennae length approximately twice GHW except in *L. cowleyi* where it is slightly < GHW; 11 segmented, segments simple; FS1 longer than pedicel; all FS at least twice as long as wide; apical FS not shortened and club-like, no FS produced laterally or flattened

Legs. No femora and tibiae curved or swollen. MFC absent.

Abdomen. Posterior margin of basal abdominal sternites not recurved. Light organs occupying sternite 6, sometimes slightly retracted from lateral and posterior margins (may be a post-mortem effect); light organ may occupy all of sternite 7 except for a narrow clear posterior band, or may be restricted to the anterior half or less. Sternite 7 MPP always developed, scarcely produced, wider than long and apically rounded in *L. dejeani*, sometimes conspicuously produced, often apically emarginate; MPP never upturned or engulfed by the downturned apex of tergite 8; posterolateral corners of sternite 7 rounded or angulate, not produced posteriorly; posterior margin lacking incurving lobes, pointed projections, median carina, median trough and dimple; posterior half of sternite 7 not arched or swollen. Tergite 8 symmetrical, not wider than long, projecting to or just extending beyond the posterior margin of sternite 7; median posterior area not narrowed, downturned and engulfing the MPP; ventral surface lacking lateral ridges and flanges in *cowleyi*; with lateral ridges and no flanges in *australis*, *flavicollis*, *nigra* and *orapallida*; tergite 8 pale in *australis*, *dejeani* and *orapallida*, dark brown or black in *flavicollis* and *nigra*.

Aedeagal Sheath. Symmetrical, lacking lateral protuberances of tergite, with anterior half of sternite 9 elongate, narrowed and symmetrical; sheath elongate, slender and symmetrical in *cowleyi*, *nigra*, *australis*, *flavicollis*; posterior half of sternite 9 symmetrical, and extending as far as posterior margin of tergite 9 in *nigra*, *australis*, *flavicollis*, posterior half of sternite shortened in *orapallida*, and narrowed, apically emarginate and not reaching to posterior margin of tergite 9 in *cowleyi*; tergite 9 slender tapering posteriorly and scarcely visible. Aedeagus elongate and slender in *nigra*, *australis*, *flavicollis* and *orapallida*, with ML narrow at apex, slightly longer than LL which narrow towards their apices and are separated and closely approximate along their dorsal length; apices of LL not visible from below; in *orapallida* the LL are widely separated but not divergent at narrowed apices; in *cowleyi* the ML is considerably shorter than the LL which are expanded in their basal 1/2 -2/3 and contiguous ventrally, and narrowed and widely separated in their apical 1/4-1/2; apices of LL are visible from above and below and bear small hairy lobes along their inner ventral surface; in *dejeani* the ML is subequal in length to the LL which are as broad at their apices as at their bases, and bear elongate narrowed flaps along their inner ventral surface.

FEMALE. Macropterous.

Pronotum. Outline similar to that of male, but anterolateral angles usually more rounded and midanterior margin often not much produced beyond anterolateral angles.

Elytra. Interstitial lines feebly developed.

Head. Small, concealed beneath pronotum at rest; shallowly depressed between the eyes, GHW 2-5 × SIW; mouthparts well developed; antennal length always slightly longer than GHW. Light organ material restricted to the ventral surface of sternite 6 only; sternites 7 and 8 tapering posteriorly, and often medially emarginate.

LARVA. Lacking laterally projecting acute tergal margins; legs with tarsal claw about 1/3 as long as tibiotarsus.

REMARKS. *Luciola* (*sensu* McDermott, 1966) is widely distributed throughout Europe, Asia and the Pacific and its morphological diversity was discussed by Ballantyne (1968). It is an heterogeneous assemblage which McDermott (1964), Ballantyne & McLean (1970) and Ballantyne (1968, 1987a, 1987b) all considered to be in major need of revision. This need is supported by the following phylogenetic analysis.

Luciola is redescribed here from Australian species identified as species groups in the cladistic analysis, and comprises 3 distinctive groups: i) *dejeani* (which may not be Australian); ii) *cowleyi*; iii) an Australian and New Guinean element of *australis*, *flavicollis*, *nigra* and *orapallida* sp. nov. *Luciola dejeani* is known from one Australian record and *L. cowleyi* from isolated records across the Gulf of Carpentaria and 'NW Australia', except for a sole record of *cowleyi* from Kuranda, which is probably incorrect. Similarities with African and Indian species are discussed later for both of these species. Of the remaining category *flavicollis* and *nigra*, which also occur in New Guinea (Ballantyne, 1992), are widely distributed along the eastern seaboard of Queensland as far south as Brisbane.

KEY TO MALES OF AUSTRALIAN *LUCIOLA*

1 Dorsal surface pale yellow, with elytral apices black . . . . *dejeani* Gemminger

Dorsal surfaces variously coloured but never entirely yellow with only the elytral apices black 2

2. Median posterior margin of sternite 7 either not produced, or at most slightly produced and apically rounded or slightly emarginate, with lateral margins converging posteriorly 3

Median posterior projection of sternite 7 considerably produced posteriorly, apically emarginate or truncate, with lateral margins subparallel sided 4

3 Underside of thorax (excluding legs) and/or abdomen (except light organs) always with some dark brown to black markings; pronotum with median dark markings; posterolateral excavation of eyes pronounced and clearly visible when head is in withdrawn condition; median posterior margin of sternite 7 not produced . . . . *cowleyi* Blackburn

Underside of thorax (excluding legs) and abdomen (excluding light organs) pale yellow; pronotum yellow, lacking dark markings; posterolateral excavation of eyes not pronounced and not visible when head is in withdrawn condition; median posterior margin of sternite 7 a little produced, apically rounded or emarginate . . . . *australis* F.

4 Elytra very dark brown with no paler markings, ventral surface black except for pale light organ in sternites 6, 7 . . . . *nigra* Olivier

Elytra pale to dark brown, always with paler markings either at base and/or along lateral and/or sutural margins; ventral surface not always entirely black except for white light organs 5

5 Elytra brown, with bases and apices brown, and lateral margins widely pale; most of ventral surface of body pale; aedeagus (Fig. 21O-Q) with lateral lobes very narrow and widely separated dorsally . . . . *orapallida* sp. nov.

Elytra brown, always with some orange markings, either across base, and/or suture, and/or lateral margin; most of ventral surface of body very dark brown; aedeagus with lateral lobes closely approaching dorsally (Fig. 21U-W) . *flavicollis* MacLeay

KEY TO KNOWN FEMALES OF AUSTRALIAN *LUCIOLA*

This key includes reliably associated females, all of which are macropterous, as well as a single female from Murray Is which is treated only as *Luciola* species A.

1. Body brown except for pale light organ in sternite 7 . . . . *Luciola* sp. A

Body never all brown, at least pronotum pale orange . . 2

2. Venter of body yellow, except for white sternite 6 and brown tibiae and tarsi; elytra dark brown, margins not paler than rest . . . . *australis* F.

Venter of body dark brown except for pale light organs; or at least basal abdominal sternites dark brown; if ventral surface paler, then elytra with pale lateral and sutural margins 3

3. Elytra dark brown; margins no paler than rest . . . . *nigra* Olivier

Elytra dark brown with some paler orange markings either at base or along lateral and sutural margins . . . 4

4 Most of ventral surface of body and all of legs dark brown to black; elytra often pale orange yellow at base and/or narrowly pale margined laterally and along suture; sternites 8 and 9 black . . . . *flavicollis* MacLeay

Most of ventral surface of body, and all of legs, yellow to pale brown; elytra brown at base and widely pale margined along lateral margin and suture; sternites 8 and 9 yellow. . . . . *orapallida* sp. nov.

KEY TO KNOWN SPECIES OF *LUCIOLA* LARVAE FROM AUSTRALIA

1 Tergum 1 bearing 6 well defined tubercles along anterior margin (Fig. 22A). . . . . *australis* F.

Tergum 1 lacking well-defined tubercles along anterior margin (Fig. 22B,C) 2

2 All except terminal tergum with a wide pale median line and widely pale lateral margins (Fig. 22C) . . . . *nigra* Olivier

All terga lacking a wide pale median band and pale lateral margins . . . . *orapallida* sp.nov.

Luciola (Luciola) australis (Fabricius)
(Fig. 22)

Lampyris australis Fabricius 1775: 201; 1781: 253; 1787: 162; 1792: 102; 1801: 104. Lacordaire, 1857: 338. Motschulsky, 1854: 53 (partim). *Nec* Guérin-Méneville, 1838: 74. Boisduval, 1835: 125, plate vi, fig. 13.

Lampyris italica var. *australis* Fabricius. Olivier, G., 1790: 18, Fabricius, 1792: 104.

Luciola australis (F.). Laporte, 1833: 150. Lea, 1909: 108 (partim). Masters, 1886: 288; 1888: 327. McDermott, 1966: 99. (partim). Ballantyne, 1988: 161. Calder, 1998: 178. *Nec* Gorham, 1880: 104; Olivier, 1883: 330; 1885: 362; 1902: 74 (larva); 1907: 50; 1909b: lxxxi; 1913: 417; Olliff, 1890: 652; Lea, 1921a: 197.

Luciola pudica Olliff, 1890: 652. Lea, 1909: 109 (female). McDermott, 1966: 112. Ballantyne, 1988: 162 (Synonymy)

TYPE. Lectotype, ♂, New Holland (designated by Ballantyne, 1988) in Hunterian collection, University of Glasgow (see below).

MATERIAL. Lectotype and 131 specimens. N QLD: Cape Pallarenda, Townsville, in mangroves, 8.xii.1964, LP, GBM, 5♂, 2♀, 10 larvae (T.120 UQ). Townsville, xi.1902, F. Dodd, 3♂ (SAMA). Ross R nr Townsville, 15-16.ix.1980, J. Case 4♂, 3♀ (ANIC). 18.16S, 146.01E, Round Hill Landing 15km SE of Cardwell, in mangroves, 7.xi.1984, GBM, DC, 1♂ (QM). Bowen, 1♂ (SAMA). CENTRAL QLD: 21.09S, 149.11E, Halftide nr Mackay, 8.ii.1965, to light, E. Dahms, 2♂, 1♀ (QM). Mackay, mouth of Baker's Ck, in mangroves, to light, 7.ii.1965, E. Dahms, 4♂, 3♀ (QM). 23.11S, 150.73E, Yeppoon, iv.1961, LP, 10♂, 1♀ (UQ). Tanby, nr Yeppoon, xii.1962, J. Frisch, 5♂ (UQ). Gladstone, 23.xii.1963, GBM, 1♂ (UQ). Port Denison, 1♂ (SAMA). Pacific Highway 14m S of Gladstone at Boyne R. crossing, in mangroves, netted in flight, LP, iv. 1961 5♂, 5♀, 6 larvae (T. 47-50 UQ); 1.i.1962 3♀; 24.xii.1962 2♂. S QLD: Bundaberg, 29.x.1972, H. Frauca, 3♂, 2♀ (ANIC). NSW. No other data, 1♂, 1♀ (MM).

DIAGNOSIS. Male 5.5-7.0mm long; pronotum orange, elytra very dark brown, ventral surface mostly yellow; eyes lacking any visible postero-lateral excavation when head is withdrawn; MPP of sternite 7 rounded; sternite 7 lacking postero-lateral projections; ventral surface of tergite 8 with lateral ridges and short pointed lateral flanges. Aedeagus elongate slender, ML longer than LL which taper to their apices. Female macropterous, coloured like male except pale light organ in sternite 7 only. Larva (Fig. 22A) with small rounded protuberances along posterior margins of terga.

REMARKS. Ballantyne (1988) resolved the identity of this species and redescribed males, females and larvae. *Luciola australis* F. was the only firefly species collected by Joseph Banks during the voyage of the 'Endeavour' in 1770. Radford (1981) recorded the existence of an apparent Fabrician type in the Hunterian (entomological) collection in the Department of Zoology at the University of Glasgow. In 1983 Dr Roy Crowson determined that one of the Hunterian specimens, a male, conformed to *L. pudica* Olliff, but that the other, identified by him as a female, did not conform and was not identified (Ballantyne, 1988). In October 1993 LB examined the 2 male specimens then standing under the label *Luciola australis* F. in the Hunterian collection. LB chose the specimen on the right as being closest to the original description of *L. australis*, but comparisons could only be approximate (legs and antennae are incomplete, and the ventral surface of the metathorax and abdomen is light brown, doubtless an effect of age). The crucial feature of the original Fabricius description is that of the underside of the body viz. 'subtus flavicans'. LB cannot determine the identity of the second specimen, which is a male and also incomplete, and may have been taken in Indonesia during the latter part of the Endeavour voyage (Ballantyne, 1992).

Ballantyne & Buck (1979) described features of the larva, and Powell (1964) aspects of the biology. With the exception of one label record from NSW (no specific locality was given and is probably mislabelled) it is known from Townsville to Bundaberg, usually in mangroves.

Luciola (Luciola) cowleyi Blackburn
(Figs 19, 21)

Luciola Cowleyi Blackburn, 1897: 34. Olivier, 1902: 76; 1907: 51. Lea, 1909: 108; 1921a: 197.
Luciola (Luciola) cowleyi Blackburn. McDermott, 1966: 102. Ballantyne, 1968: 125.
Luciola quadricostata Pic, 1938: 3. Ballantyne, 1968: 125 (Synonymy).

TYPES. Holotype. ♂, *Luciola cowleyi* Blackburn, Australia, N Qld (BMNH). Holotype♂, *Luciola quadricostata* Pic, North Australia (Natural History Museum, Basel).

MATERIAL. Two types and 56 specimens. NORTHERN TERRITORY: 12.27S, 130.50E, Darwin, W.K. Hunt, 19♂ (UQ; SAM; QM; BMNH; MV); G.F. Hill, 16♂ (ANIC, UQ, SAM, MV); 11-12.ii.1945, B. Malkin, 14♂ (USNM); iii.1943, N. R Laird 1♂ (ANIC); 2.xi.1975, Conners, 2♂ (MAGNT). Port Darwin, 5♂ (SAM). Tortilla Flats via Darwin, 3.iv.1961, C. Li, 2♂ (MAGNT). 12.33S, 131.02E, Virginia nr Darwin, 4.xii.1997, S. Gregg, 1♂ (MAGNT). 13.45S, 138.41E, Daly R Mission, 2♂, 14.i.1974, at light, J. F. Hutchinson (ANIC). QLD: 1♂ (no other locality given) (SAM). 16.49S, 145.38E, Kuranda, G Bryant, F.P. Dodd, 1♂ (BMNH).

DIAGNOSIS. Males small (5-5.5mm long), pale brown; with large eyes which are almost contiguous ventrally and bear posterolateral excavations which are visible when head is withdrawn; antennal sockets contiguous, mouthparts small, no frontal area defined, no obvious frons-vertex junction; pronotum (Fig. 19C) subparallel-sided; elytra with interstitial lines 1, 2 well defined; epipleuron and sutural ridge evanescent in posterior half; abdominal sternite 7 broadly rounded posteriorly, lacking any defined median posterior projection; ventral surface of tergite 8 lacking ridges or flanges. Aedeagus with a very short median lobe and broad hair bearing lateral lobes. Females are not associated.

Male. Ballantyne (1968) redescribed and figured males.

DISTRIBUTION. Queensland records for this species require confirmation; modern collections have not located it. It is otherwise known only from the Northern Territory near Darwin (Fig. 23).

REMARKS. Lea (1909) considered this species resembled species of *Atyphella* except for the exposed head; there is a superficial colour similarity only. *Luciola cowleyi* is similar to *Luciola discicollis* Laporte, the 'West African Firefly', in size, colour and aedeagal form, but *L. discicollis* lacks the posterolateral excavation of the eye (Kaufmann, 1965). Ballantyne (1968) considered, but rejected, the possibility of *L. cowleyi* being a species of *Bourgeoisia* Olivier because of the eye excavation.

Luciola (Luciola) dejeani Gemminger
(Figs 19, 21)

Lampyris apicalis Boisduval, 1835: 127. *Nec* Eschscholtz, 1823: 114.
Luciola Dejeani Gemminger, 1870: 1651. Masters, 1886: 289. Olivier, 1902: 77; 1907: 51; 1910: 42.
Luciola dejeani Gemminger. Olliff, 1890: 652. Lea, 1909: 108; 1921a: 197; 1921b: 66.
Luciola (Luciola) dejeani Gemminger. McDermott, 1966: 103. Calder 1998: 179.

TYPE. Holotype. ♂ *Lampyris apicalis* Boisduval, New Holland, not located in MNHP by this author in Nov. 1993.

MATERIAL. 2 specimens. Australia: 1♂ (SAM), 1♂ (AM). (Specimens bear no labels other than 'Australia' but Olliff (1890) records one from the Northern Territory at the Victoria R Depot (15.40S, 130.39E).

DIAGNOSIS. Males 8.0-8.5mm long; the only Australian *Luciola* with a yellow dorsal surface and black elytral apices; superficially similar to *Atyphella costata* Lea in colouration, distinguished most obviously by the form of the aedeagus.

DESCRIPTION. *Male*. 8-8.5mm long; pronotum, MS, MP and elytra, except for an apical black area, yellow orange; head, antennae and mouthparts dark brown; ventral thorax yellow, legs yellow except for dark brown apices of tibiae, and dark brown tarsi; basal abdominal sternites yellow; sternite 5 yellow, with irregular brown markings in posterior 1/2; sternites 6 & 7 white; basal abdominal tergites yellow; tergites 6-8 brownish yellow.

Pronotum (Fig. 19B) 3.2mm wide; 1.7mm long; W/L 1.8; midanterior margin rounded, moderately strongly produced beyond anterolateral corners; lateral margins subparallel and narrowly explanate; midposterior margin indented or not. Elytra with 3 feebly elevated interstitial lines (1, 2 & 4).

Head slightly depressed between the eyes; GHW 2-2.1mm; SIW 0.8mm; ASD subequal to ASW. FS1 almost as long as scape, and slightly > FS2; FS 3-5 subequal, slightly shorter than 2 and slightly longer than subequal 6-8; FS 9 elongate, slender, slightly longer than 8; all FS more than twice as long as wide. Mouthparts well developed; apical segment labial palpi flattened and dentate.

Epipleuron and sutural ridge evanescent before elytral apex.

Light organs occupying sternites 6 & 7; retracted from lateral and posterior margins of sternites 6 and 7; sternite 7 with posterior margin rounded; posterolateral corners of sternite 7 not produced. Nature of ventral surface of tergite 8 not determined.

Aedeagus (Fig. 21L-N) with basal piece well developed but not hood like; ML not swollen at EO and tapering towards apex and slightly shorter than LL; LL broad, closely approximate dorsally for 3/4 their length, apices narrowed, widely separated and visible ventrally; bearing fine hairy lobes along their inner (ventral) margins.

DISTRIBUTION. Not reliably known, may not be Australian.

REMARKS. A definite Australian record of this species now rests on one specimen, apparently taken during Mitchell's Victoria R. expedition and tentatively designated by Olliff (1890) as *Luciola dejeani* Gemminger. Lea (1909) confirmed this identification and subsequently (1921b) described a further male, bearing Blackburn's name label '*Luciola dejeani* Gemming' but lacking a locality label. Lea presumed it came from Darwin. LB has re-examined both these specimens, which may be conspecific with *L. dubia* Olivier from India. Further specimens of *dejeani* have not been located and LB believes that the original specimen Olliff saw may have been mislabelled. It is absent from recent collections from MAGNT, but LB has examined four males of the similarly coloured *A. costata* from Victoria River Depot which is close to Timber Ck.

If there are two species of Australian Lampyridae with pale dorsal colouration of yellow with black tipped elytra, viz. *A. costata* (Lea) and *L. dejeani* Gemm., then a single line of Boisduval's (1835) description, viz. 'dessous jaune', becomes critical in their separation. Only the two specimens assigned here approach the description of *L. dejeani*; *costata* has at least two dark abdominal sternites and is transferred to *Atyphella*.

Lea (1921b) described the abdomen of the second male with an additional segment 'a very small white one, inconspicuously attached to the tip of the fifth, and obscured by pubescence'. There is no additional segment; he was referring to either the tip of the aedeagus or the aedeagal sheath.

Luciola (Luciola) flavicollis Macleay
(Figs 19, 20, 21, 22)

Luciola flavicollis Macleay, 1872: 263. Masters, 1886: 289. Olliff, 1890: 653. Olivier, 1902: 79; 1907: 52; 1910: 42. Lea, 1909: 109; 1921a: 197; 1921b: 65. *Nec* Armitage, 1908: 28.

Luciola (Luciola) flavicollis Macleay. McDermott, 1966: 104. Calder, 1998: 179.

Luciola Gestroi Olivier, 1885: 366; 1902: 79; 1907: 52; 1910: 42; 1913: 417 (Synonymy). Masters, 1886: 289. McDermott, 1966: 104.

Luciola gestroi Olivier, 1909b: lxxxi. Lea, 1909: 109. (Synonymy).

Luciola coarcticollis Olivier, 1888: 59; 1902: 76; 1907: 51; 1909b: lxxxi; 1910: 42. Lea, 1909: 109 (Synonymy).

Luciola flavicollis var. *courcticollis* Olivier. McDermott, 1966: 104 (Synonymy).

Nec Luciola gestroi var. *nigra* Olivier, 1885: 366. McDermott, 1966: 104.

TYPES. Holotype. ♀ *Luciola flavicollis* Macleay S Qld: 25.37S, 151.37E, Gayndah (AM). Paratypes, *Luciola flavicollis*, 5 ♂, 2 ♀ S Qld: Wide Bay and Gayndah; Northern Territory: Port Darwin (AM, ANIC, SAM). Syntype♂ *Luciola gestroi* Olivier N Qld: Cape York (MCG).

Syntype ♂ *Luciola gestroi* var. *nigra* N Qld: Cape York, Somerset (MCG). Holotype♂ *Luciola coarcticollis* locality in Australia unknown (MNHP, Box 72 of Olivier collection).

MATERIAL. Eleven types and 285 specimens. Variability in elytral colour pattern is indicated against individual specimens as follows: Bp = base of elytra pale (Fig. 19G-J); Sd = sides of elytra dark (Fig. 19H); Bd = base of elytra dark (Fig. 19K). Unless otherwise indicated the lateral and sutural margins are at least narrowly pale. NORTHERN TERRITORY: 11.09S, 132.09E, Black Point, Coburg Pen., 15-23.ii.1977, TW, 1♂ Bd, (ANIC). 12.15S, 136.49E, Eldo, 8ml S of Gove airport, 12-16.i.1971, TW & A. Allwood, 2♂ Bp (MAGNT) 12.26S, 130.56E, Thorak Reserve via Berrimah, 28.ii.1974, ex light trap, A. Allwood, 1♂ Bp. 12.28S, 130.50 E Darwin, 14.v.1962, C. Li, 1♀Bp; A. Lea, 2♀ Bp (SAM). Lee Point, Darwin, 8.iii.1967, MU, 2♂ Bd (ANIC). Nightcliff, Darwin, 10.v.1955, L. Crawford, 1♀ Bd (MAGNT). Port Darwin, 3♂Bp 1♀Bd (SAM); 2♀Bd, 1♀ Bp (BMNH); iii.1909, 1♂ Bd (BMNH). 12.33S, 131.02E, Virginia, xi.1997-15.i 1998,S, Gregg, 8♂ Bd, 1♀Bp (MAGNT). 13.21S, 131.08E, Robin Falls, c. 12kms S of Adelaide R, MV light, 3.xii.1980, M. Malipatil, 1♂ Bd. 13.58S, 130.56E, Daly R, 'Dargie's', 7.1.1956, L. Crawford, 1♂Bp. 13.58S, 136.27E, Angurugu, 3.xii.1976, J. Waddy, 1♀ Bp. 14.28S, 132.16E, Katherine, at light, 7.ii.1968, J. Watson, 1♂, 3♀ Bp, Sd; 9.ii.1968 1♀Bp, Sd (ANIC); at light 6-10.xi.1968, E. Matthews, 5♀ Bp, Sd. 14.31S, 132.22E, Tindal, 1-20.xii.1967, light trap, W. Vestjens, 5♂, 1♀ Bp, Sd. GULF OF CARPENTARIA: 16.00S, 137.30E, Pellew group, Horn Islet, 15-21. ii. 1968, BC, 3♂, 3♀ Bp, Sd ; 1-7 . ii. 1968, 20♂, 5♀ Bp, Sd (UQ). Pellew group, South West Is., 7.ii.1968, BC, 1♂, 1♀, Bp, Sd. Groote Eylandt, Tindale, 2♂ Bd, 1♂ Bp (SAM); 21.i.1925, G Wilkins, 1♂ Bp (BMNH). QLD: Cape York Pen.: 10.48S, 142.28E, 3kms E. of Lockerbie, 30.i-4.ii.1975, GBM, RF, 1♀ Bd at MV light (QM). Lockerbie area, 13-27.iv.1973, GBM, 1♀ Bd. 10.53S, 142.24E, Bamaga, i.1969, R. Trundle, 2♂ Bd (UQ). 12.41S, 141.53E, Hibbard Point, Weipa, GBM, 3-6.ii.1976, 1♀; 5-8.ii.1975, 1♂ Bd (QM). 12.43S, 143.17E, Quinn Park, Claudie R, 12-21.ii.1985, E. Edwards, B. Hacobian, 1♂ Bp (ANIC). Claudie R nr Mt Lamond, 5-19.i.1972, DKM & G Holloway, 2♂, 2♀ Bd (AM). 12.43S,143.18E, 11km ENE of Mt Tozer, 11-16.vii.1986, TW, A. Calder, 1♂ Bd (ANIC). 12.44S, 143.17E, Iron Ra.: 28.iv.1968-5.v.1968, GBM, 7♂, 4♀, (4♂, 1♀ Bd 2♂, 3♀ Bp); 5-10.v.1968, 4♂, 4♀, Bp; 11-17.v.1968, 11♂, 4♀ Bd; 26-31.v.1971, 2♂, 1♀ (1♂ Bp, 1♀Bd) (UQ); 1-4.v.1973, 2♂ Bd (QM); v.1966, GB, 2♂ Bd (ANIC), 14.v.1971, 2♂ Bd (MV), v.1971, 3♂, 3♀ Bd (ANIC); 13.v.1971 at light, 5♂, 1♀ Bd,100', GB (BMNH); 2♂ 1♀ Bd (SAM). 12.46S,143.17E, Claudie R, 1♂ Bd (MV); nr Mt Lamond, 5-19.i.1972, DKM, 3♂ Bd, 1♀ Bd (AM). E Claudie R, 1.vii.1982, MV light, M. Schneider, G Daniels, 1♂ Bd (UQ). W Claudie R, Iron Ra., 3-10.xii.1985, in RF, 50m, GBM, DC, 1♂ Bd (QM). 15.05S,145.20E, Gap Ck, 5km ESE of Mt Finnigan, 13-16.v.1981, A. Calder, 1 ♀ Bd (ANIC). 15.28S,141.45E, Mitchell R Mission, iii.1966, H. Standfast , 3♂ Bp, 8♂ Bd (UQ); 1.iv.1960, E. Marks, 1♂ Bp; iv.1969, A. Dyce, 2♂ Bp (ANIC). Silver Plains, JLW, 15♀, 1♂ Bd (6♀ taken 1-iv.1960 at homestead) (ANIC); 11.xii.1964, 3♂ Bp, 2 larvae (T.132, UQ). Goanna Ck, 17.ii.1964, 3♂ Bp (T.77). 15.48S,145.25E, Cooktown, i.1971, GB, 1♂ 1♀ Bd (ANIC). 16.05S, 145.29E, Cape Tribulation, 22.ix-7.x.1982, GBM, DY, GT, 1♀ Bd (QM); 24-28.xii.1981, N.Gough, R. Storey, 2♂ (DPI); Youth Hostel, 8-10.xii.1984, R.de Keyzer, 1♀ Bd (UQ). C.Tribulation area, 11.v.1992, JL, 1♂ Bd (ANIC); 21-28.iii.1984, A. Calder, TW, 2♂ Bd taken with one *L. nigra* (ANIC). Upper Daintree R, 27.xii.1964, GBM, 1♂Bd (UQ). Cow Bay, N of Daintree, 18-25.i.1984, I. Cunningham, 1♂ (DPI). 16.49S,145.38E, Kuranda, 1500', 9.x.1951, J. Sedlacek, 1♀ Bd (UQ). 16.53S,145.42E, Redlynch, R. Tillyard, 1♂, 1♀ Bd (MV); 4.xii.1939, R. Wind, 13♂ Bd (BMNH). 16.55S,145.46E, Cairns, A. Lea, 16♂Bd, 2♀Bd (4 attracted to light; AM; SAM); GB, ii.1950, 3♂ Bd (ANIC), xii.1950, 2♂, 1♀ Bd; 6♂, 4♀Bd (MV); 3♂, 2♀ Bd (BMNH);7♂, 3♀ Bd (ANIC); 16.iv.1960, K. Harley, 2♂ Bd. 17.08S, 145.13E, Mutchilba, ii.1933, A. Selby, 3♂ Bp (MV). 17.34S, 145.55E, Coorumba, R. Mulder, 27-28.v.1983,1♂, 5♀ Bd (AM). 18.39S,146.10E, Ingham, 4.ii.1961, I. Cook, 2♂ Bd (UQ); 8.ii.1972 N. McFarland, 2♂, 1♀ Bd (ANIC). 19.30S, 146.58E, Mt Elliot NP 9-10.ii.1990, K. Dunn, T.

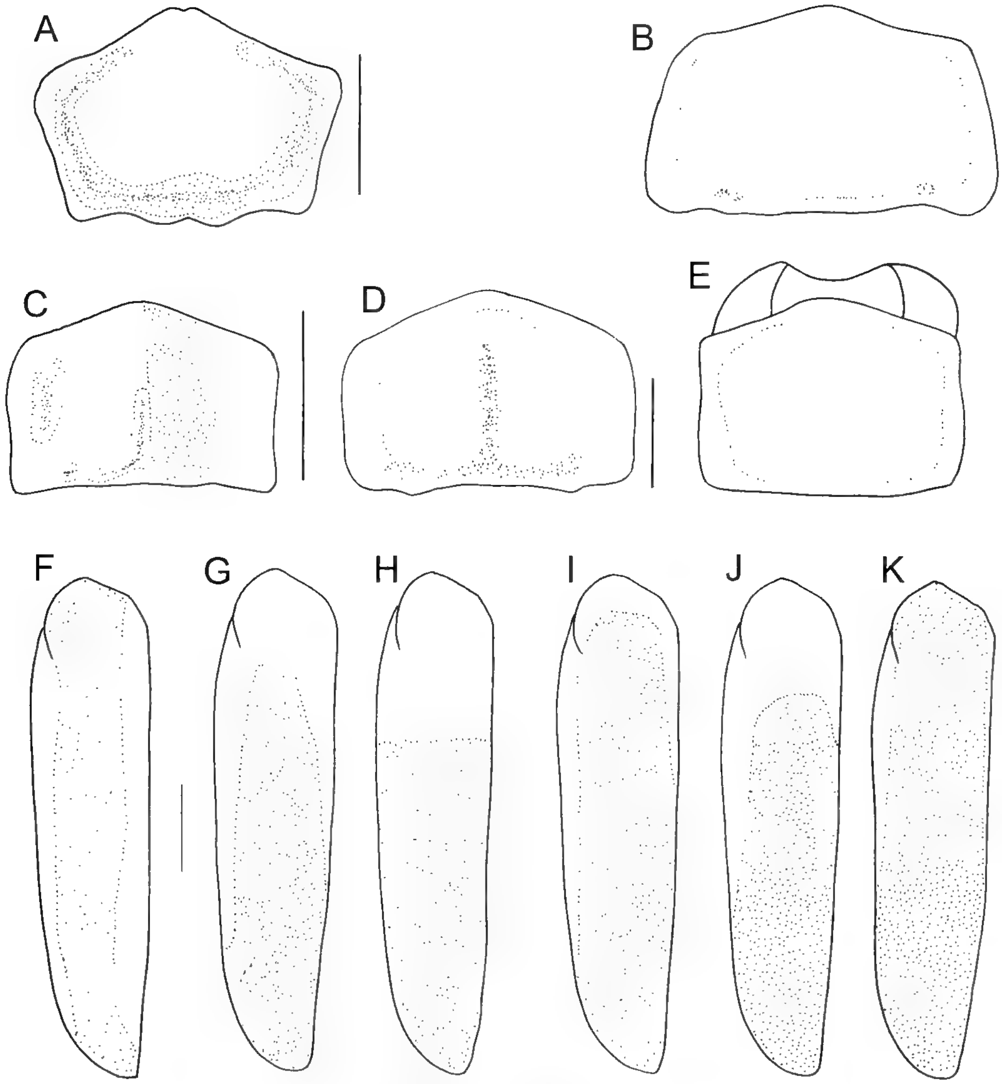


FIG. 19. *Luciola* spp. A-E, dorsal view of pronota; F-K, dorsal view, left elytron. A, G-K, *L. flavicollis*; B, *L dejeani*; C, *L cowleyi* (left side indicates sculpturing, right side colour pattern); D, *L. nigra*;E, F, *L orapallida* (E with anterior margin of head). Elytral colour patterns described in text as Bp (G-J); Sd (H); Bd (K). Scale lines 1mm; lines shared by A, B; C, E; G-K are not to scale.

Woodger, 1♂ Bd. 19.34S,147.24E, Ayr, i. 1961, I. Bayly, 1♀ Bp (UQ). 20.15S,148.23E, Greta Ck, 20mi. N of Proserpine, 1.i.1965, GBM, 1♂, 1♀Bp (QM); 1.i.1965, H. Rose, 2♂ (1 Bp1 Bd) (UQ). 21.09S, 149.11E, Mackay, ii.1964, E. Dunwoody, 1♂. 21.18S, 149.18E, Halftide, nr Mackay, 8.ii.1965, to light, E. Dahms 1♂ Bp (QM). 23.08S, 150.22E, Yaamba, attracted to light, 4-5.i.1962, LP, 1♂ Bd, 9.1.1962, 1♂Bp (UQ). 23.11S,150.73E, Yeppoon, 25.i.1975, H. & A. Howden, 2♂ Bp (ANIC). 23.22S, 150.32E, Caves (probably Olsen's Caves) nr Rockhampton, R. Higgins, 3♀, 2♂ Bp (QM). 24.53S, 147.40E, Carnarvon, 31.i.1962, E. Exley, 1♂ Bp (UQ). 26.03S, 152.24E, Woolooga, 20.viii.1965, R. Drew, 1♂ Bd.

DIAGNOSIS. Males small (4.5-6.5mm long); pronotum orange; elytra light or dark brown, always with some paler yellow or orange markings along sides or across base; ventral body very dark brown to black except for pale yellow prothorax, yellow areas of legs, and white light

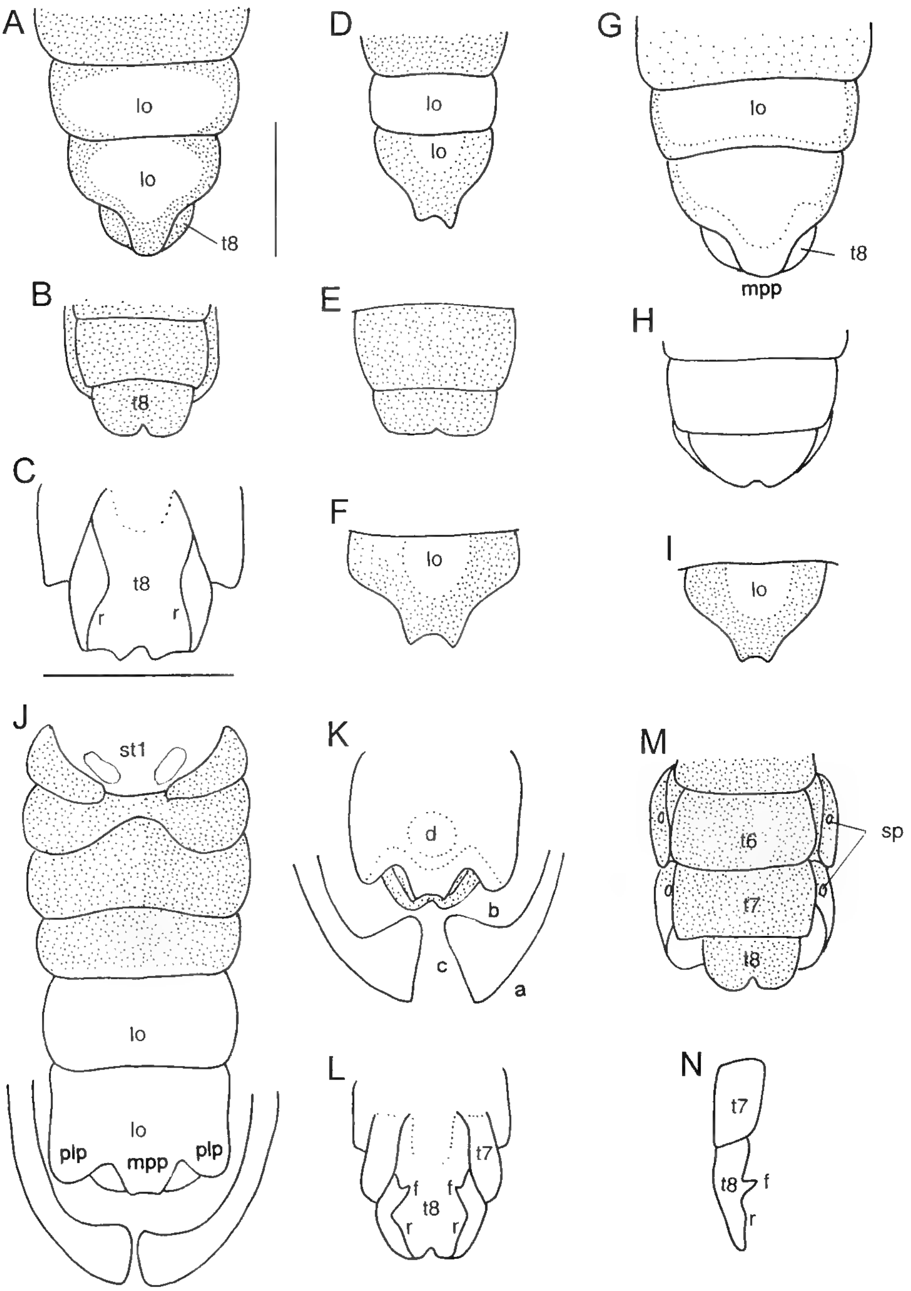


FIG. 20. A-I, Terminal abdomens of *Luciola* spp. A,D,G,F,I, ventral aspect terminal sternites; B,E,H dorsal aspect terminal tergites; C, ventral aspect terminal tergites. A-C, *Luciola nigra*; D-F, I, *L. flavicollis*; G, H, *L. orapallida*. J-N,Terminal abdomens of *Pteroptyx* spp. J,K, entire abdomen (J) or sternite 7 only (K) with deflexed elytral apices; M, dorsal aspect terminal tergites; L, N, ventral (L) and right lateral (N) aspects of terminal tergites. J, L-N, *P. platygaster*; K, *P. cribellata*. Scale lines 1mm; lines shared by A-B, D-N; C. a-c = dimensions of deflexed elytral apex; d = dimple; f = flange; lo = light organ; mpp = median posterior projection sternite 7; plp = posterolateral projection sternite 7; r = ridge; st 1 = sternite (ventrite) 1; t7,8 = tergites 7, 8.

organ; any posterolateral excavation of eyes hidden when head is withdrawn into pronotum; MPP of sternite 7 prolonged, sub-parallel-sided and apically emarginate; posterolateral corners of sternite 7 defined and rounded. Female macropterous, coloured as for male except pale light organ in sternite 6 only.

DESCRIPTION. Females are redescribed; males and larvae are newly described.

Male. 4.5-6.5mm long; pronotum, MS and MN orange; elytra (Fig. 19G-K) moderately light to quite dark brown, with suture and lateral margins yellow at least in basal 1/4; (specimens from Olsen's Caves have yellow elytra with pale brown markings); base of elytra either light to quite dark brown, or orange yellow in basal 1/6-1/3); variability in elytral colour pattern is indicated above; males from same locality showed such variability; head black, antennae black or reddish orange; ventral prothorax orange, meso and metathorax dark brown to black, occasionally orange; legs 1 dark brown to black except for orange coxae, trochanters and most of femora; legs 2 and 3 black except for orange coxae, trochanters and base of femora; ventral abdomen dark brown or black except for white sternite 6 (lateral margins of which may be dark if light organ does not reach lateral margin), and white light organ in the anterior half of 7; all abdominal tergites black.

Pronotum 1.2-1.8mm wide; 1.0-1.3mm long; W/L typical male 1.4; midanterior margin considerably produced beyond anterolateral corners; lateral margins sub-parallel or converging posteriorly; depressed areas as figured (Fig. 19A); punctures contiguous over most of disc. Head deeply depressed between eyes; GHW 1.1-1.5mm; SIW 0.3-0.4mm; ASD subequal to ASW. FS 1 slightly longer than remaining subequal FS.

Elytral epipleuron and sutural ridge evanescent before elytral apex.

Light organs occupying sternite 6 entirely and sternite 7 in median anterior half or less (Fig. 20D-F,I); MPP of sternite 7 well developed, sub-parallel sided, apically emarginate, sometimes slightly asymmetrical at apex. Ventral surface of tergite 8 with lateral ridges, lacking flanges. Aedeagus (Fig. 21U-W) with ML slightly swollen at apex, and bearing a median dorsal ridge which is irregularly serrated; LL broad at their apices, which bear incurving hooks on the ventral surface of their inner apical angles.

Female. 5.4-6.0mm long (holotype 6.0mm). Macropterous. Coloured as for male except white light organ confined to sternite 6, and sternites 7 & 8 black. Holotype female dorsal colour pattern is Bd; females show same variability in dorsal colour pattern as males. Pronotal outline similar to that of male. Median posterior margin of sternite 8 broadly and shallowly emarginate, of 9 entire.

Larva. Presumed *flavicollis* larvae differ only from larvae of *L. nigra* in lacking the pronounced marginal tubercles in the anterior half of tergum 1 and in having deep grooves in the posterior 1/4 of the protergum.

DISTRIBUTION. New Guinea (Olivier 1913), northern Australia and Gulf of Carpentaria islands, and south along the east coast of Queensland to Woolooga near Gympie. Often from open forest where it may be attracted to light; not known from rainforest (Fig. 24). Olivier (1913) recorded *L. gestroi* from New Guinea.

REMARKS. Macleay (1872) confused the sexes, and consequently described the terminal abdomen inaccurately. Olliff (1890) described as luminous the penultimate segment of the female (only the antepenultimate, sternite 7, bears the light organ). Lea (1921b) correctly described the female abdomen but incorrectly attributed a medio-basal white patch to the 'subapical' abdominal segment of the male (the light organ is reduced to a 'sub-apical patch' as he described on the terminal abdominal sternite only). Lea (1909) indicated the Victoria record for *L. coarcticollis* was erroneous, and recorded the species from northwestern Australia, Northern Territory and South Australia. The South Australian record is also false. LB has been unable to relocate all these specimens.

Armitage (1908) described the 'Queensland firefly beetle' with entirely dark elytra and misidentified it as *L. flavicollis*. His specimens were either *L. nigra* or a *Pteroptyx* sp.

Dorsal colour patterns vary, often between males and/or females from the one site. The BpSd colour pattern is restricted to Katherine and the Pellew Islands group.

Luciola (Luciola) nigra Olivier
(Figs 19, 20, 21, 22, 36D)

Luciola Gestroi var. *nigra* Olivier, 1885: 366.

Luciola (Luciola) nigra Olivier stat. nov. Ballantyne in Calder, 1998: 179.

Luciola humilis Olivier, 1896: 2; 1902: 80; 1907: 52. Lea. 1909: 108; 1921a: 7. Ballantyne in Calder, 1998: 179.

Luciola (Luciola) humilis Olivier. McDermott, 1966: 105. Ballantyne in Calder, 1998: 179 (synonymy).

Luciola scutellaris Lea, 1929: 344. Ballantyne in Calder, 1998: 179 (synonymy).

Luciola (Luciola) scutellaris Lea. McDermott, 1966: 113.

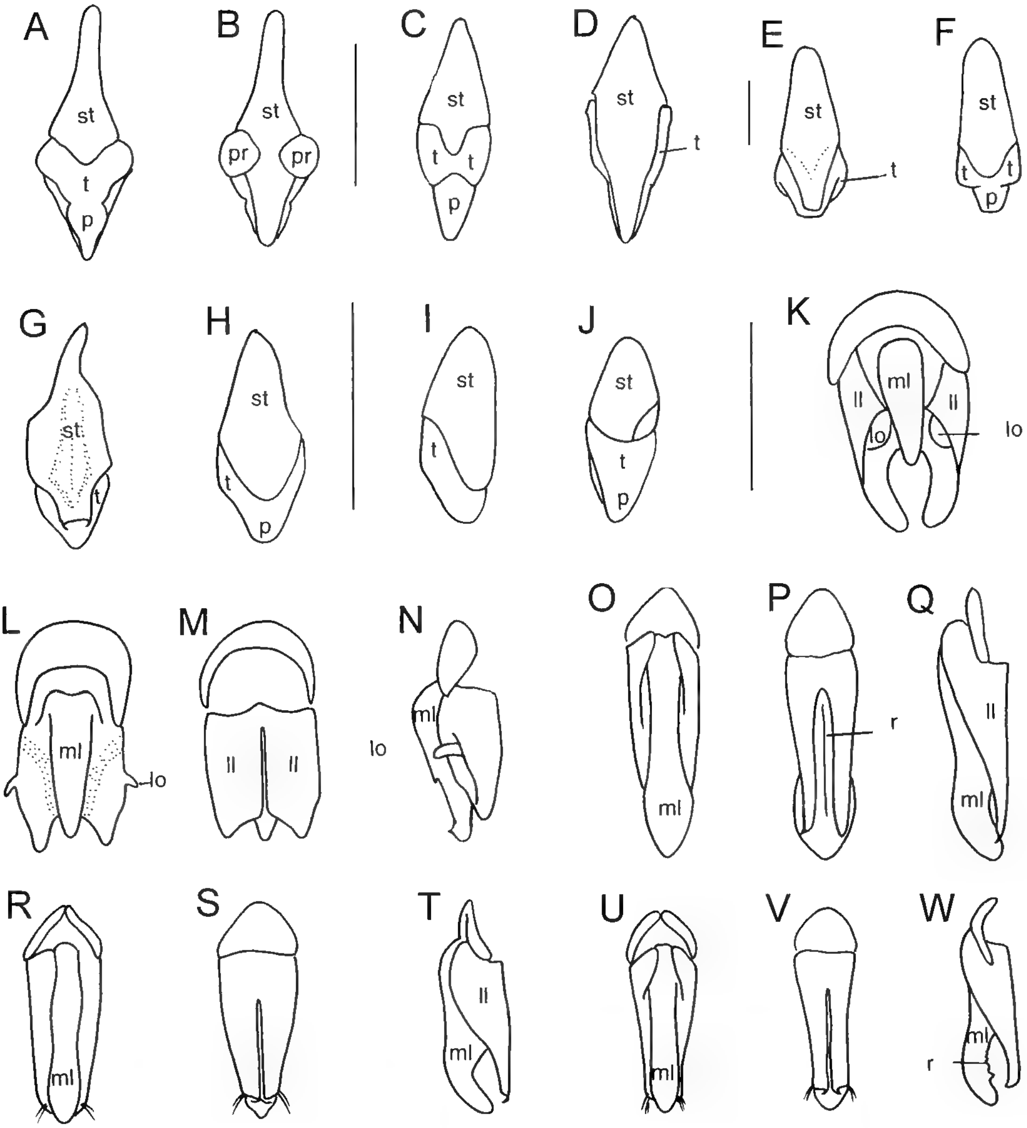


FIG 21. Aedeagal sheaths and aedeagi of *Luciola*, *Pteroptyx* and *Atyphella* spp. A-J, aedeagal sheaths, dorsal (A, C, F, H, J), ventral (B, D, G, I). K-W, aedeagi, ventral (K, L, O, R, U), dorsal (M, P,S, V) and left lateral (N, Q, T, W). A-D, *Pteroptyx* sp.; E, F, O-Q, *L. orapallida*; G, H, K, *L. cowleyi*; I, J, *Atyphella* sp.; L-N, *L. dejeani*; R-T, *L. nigra*; U-W, *L. flavicollis*. Scale lines 1mm; lines shared by: A-D; I, J; L-W. ll = lateral lobe; lo = fleshy lobe of lateral lobe; ml = median lobe; p = protiger; pr = paraprocts; r = ridge; st = sternite 9 of aedeagal sheath; t = tergite 9 of aedeagal sheath.

TYPES. Holotype. ♂, *Luciola humilis* N Qld: Cairns (BMNH). Paratypes, 4♂ 4♀ *Luciola scutellaris* Northern Territory: Gulf of Carpentaria: 13.09-14.06S, 136.28-136.38E, Groote Eylandt , N. Tindale (117051, SAM; QM). Paratype♂ *Luciola gestroi* var. *nigra*: N Qld, Cape York, Somerset Is. (MCG).

MATERIAL. 7 types and 432 specimens. Specimens with mesoscutellum black are indicated thus: #. NORTHERN TERRITORY: 11.01S, 136.45E, Rimbija Is, Wessell Islands, 21.i.1977, E. Edwards, 1♂ # (ANIC). 11.07S, 132.08E, Smith Point, Cobourg (sic) Pen., 5-6.ii.1977, R. Lewis, 1♂; 26.i.1977, E. Edwards, 1♂ #. 11.09S, 132.09E, Black Point, Coburg Pen., 15-23.ii.1977, TW, 1♂, 1♀ #; 24.i.1977, E. Edwards, 1♀. Lee Point, Darwin, 7-8.iii.1967, 1♀, 1♂, 6♂ #; 4 mi. S of Lee Point, 6.iii.1967, MU, 1♂ # . 12.52S, 132.50E, Kakadu NP, Nourlangie Camp, 17-18.xi.1979, MV light, M. Malipatil, 1♂ # (MAGNT). 13.33S, 131.13E, Green Ant Ck, 40 ml S Adelaide R, 25.i.1971, TW, A. Allwood, 2♂, 1♀. NW AUSTRALIA: 2♂ (ANIC). TORRES STRAIT: Murray Is., 10m, 26.ii.1984, J Sedlacek, 1♀ # (QM). QLD: 12.44S, 143.15E, Claudie R, xi.1912-ii.1913, J. Kershaw, 4♂ (ANIC). 13.57S, 143.12E, Coen, Cape York Pen., 4mi. N on road to aerodrome, 21.xii.1964, LP, 3♂, 7♀ (T.146, UQ). Mt White, via Coen, 21.xii.1964, LP, 2♂, 1♀ (T.145). Breakfast Ck, Silver Plains, Cape York Pen., 11.xii.1964, JLW, 1♀, 1 larva (T.141); 12.xii.1964, LP, pr in cop, # (T.128). 14.07S, 142.32E, Stewart R, 1-ii.1927, Hale, Tindale, 1♂ # (SAM). 15.50S, 145.20E, Gap Ck, 5km ESE of Mt. Finnigan, 13-16.v.1981, A. Calder, 2♂, 1♀ (ANIC). 16.05S, 145.29E, Cape Tribulation, at Youth Hostel, 8-10.xii.1984, R. de Keyzer, 1♂ (UQ). Cape Tribulation area, 1-11.v.1992, JL, 2♂ # (ANIC). 16.08S, 145.17E, Cooper Ck, 13mi. N of Daintree R., 29-31.xii.1972, BC, 2♂, 3♀ (UQ). 16.28S, 145.23E, Mossman Gorge, 320ft, at light, 31.x.1966, EB, 1♂ (ANIC). Mossman Gorge, via Mossman, 25-26.xii.1964, GBM, 2♂, 1♀ (UQ), 1♂ (T.134 UQ). 3mi. W of Mossman, iii.1964, IC & MU, 1♂ (ANIC). 16.41S, 145.20E, Bakers Blue Mts., 17km W of Mt. Molloy, 30.xii.1989-9.i.1990. ANZSES Exped., 800-1000 m , 18♂ (1♂ #), 5 E (1♀ #) (QM). 16.45S, 145.36E, Black Mt Rd, 11.4 road kms from Kennedy Hwy; 8km NNW of Kuranda, Stop A-27, 26.ii.1988, D. Rentz, 1♂ # (ANIC). 16.49S, 145.38E, Kuranda, 20.i.1919, F. P. Dodd, 2♂, 1♀ (UQ); 28.xii.1963, GBM, 3♂ (T.19); 2.iii.1908, R. Armitage, 4♂, 3♀ (3♂, 2♀#; MV); 4♂, 4♀ (SAM); ii.1914, F. Dodd, 2♂, 3♀ (1♂, 2♀ # ; SAM). Barron Falls, 2.i.1965, GB, 1♂ (ANIC). 16.49S 145.11E, Hann Tbld (N end), 11-14.xii.1995, RF, 950-1000m, GBM, GT, 1 larva (QM). 16.53S, 145.42E, Redlynch, R Wind, 21.x.1983 1♂, 1♀ #; 4.xii.1983 5♂ (1♂ #), 2♀ (1♀ #); xii.1938, R. Sternitzky, 1♂, 7♀ (BMNH). 16.54S, 145.44E, Edge Hill, xii. 1966, GB, 3♂ (ANIC). 16.55S, 145.15E, Hann Tbld Radar Station, 950m, 26-27.xi.1998, CB, 1♂ (QM). 16.55S, 145.40E, Mt Williams summit, 1000m, 27.xi.1997–6.ii.1998, RF FIT, GBM & DC, 1♂. 16.55S, 145.46E, Cairns: E. Allen, 1♂#, 1♂, 1♀, 2♀ # (ANIC; MV); H. Carter, 1♂, 1♂ #, 1♀ (MV); x.1921, A. Lea, 1♂ (MV); A. Lea, 2♂, 4♀ (1♀#; SAM); 21.xii.1981, T. Hawkeswood, at light, 1♂ (ANIC); 3♂ (1♂ #), 2♀ # (MV); 23.xi.1934 2♂ # (ANIC); 4♂ (1♂#), 4♀ (MM, SAM); 5♂ (3 #), 4♀ (2 #) (BMNH). Crystal Cascades, via Cairns: 9.xii.1964, LP, 4♀, 16♂ (UQ), 2♂, 2 larvae (T.148); 29.xii.1963, GBM, 1♂, 3♀ (T. 9, 10). 17.05S, 145.47E, Gordonvale, 1930, E. Allen, 1♂ #, 1♂, 1♀ (QM). 17.05S, 145.46E, Meringa, 1♂ (MV). 17.16S, 145.29E, Atherton, 30.i.1960, G. Ettershank, 1♂ (UQ); ii.1975, H. Howden, 9♂, 1♀ (2♂, 1♀ #) (OTT). 17.10S, 145.33E, Kauri Ck, Tinaroo Dam, 24.iv.1970, GBM, 1♂ # (UQ). 17.12S, 145.51E, Bellenden Ker Ra., Cableway Base Stn., 100m, 17.x-9.xi.1981, Earthwatch/Qld Museum, RF, 1♂, 3♀ at MV light, 1♂, beating (ANIC). 17.16S, 145.29E, Tolga scrub, via Atherton, 28.xi.1964, R. Elder, 2♂, 1♀ (T.205 UQ). 17.17S, 145.37E, Lake Eacham, 6.i.1964, GBM, 1♂ (T.8). 17.20S, 145.25E, Baldy Mt Rd, 2.7km from S end, 30.xi.1997-5.ii.1998, 1160m, open forest intercept, GBM & DC, 1♀ (QM). 17.21S, 145.56E, Boulders, via Babinda, 15.xii.1966, BC, 1♂ (T.213, UQ). 17.28S, 146.01E, Stone Ck via Garradunga, 14-19.iv.1997, GBM, CB, 2♂ (QM); 15-18.iv.1997, 100m, GBM, Russell, Ovenden, 1♂, 1♀ (QM). 17.31S, 145.37E, Millaa Millaa Falls, 10-11.xii.1966, BC, 24♂, 7♀ (UQ), 2♂ (QM); 5.xii.1965, GBM, 2♂, 1♀ (T.198 UQ). 17.32S, 146.01E, Innisfail, i.1964, J. Gilchrist, 1♂ (taken with *P. cribellata* and *L. flavicollis*) (T.84, UQ); 25.v.1961, G. Shaw, 1♂. 17.33S, 145.31E, Chilverton, 22.xii.1964, H. Rose, 9♂, 6♀ (T.150 UQ). 17.34S, 145.55E, Coorumba, R. Mulder, 18.11.1975, 1♂; 26.iii.1977, 1♂; 28.v.1983, 4♂, 1♀ (AM). 17.36S, 145.45E, Henrietta Ck, 6.xii.1965, GBM, 10♀ (T.187 UQ). 17.36S, 145.29E, Ravenshoe, 23.xii.1964, H. Rose, 1♂; 28.xii.1964, GBM, 7♂. 17.54S, 145.39E, Tully R causeway, 750m, 2.xii.1998, GBM, DC, P. Bouchard, 1♂ (QM). 18.22S, 146.15E, Hinchinbrook Is., Black Sands Beach, 21.i.1987, SH, 3♂ (2♂ #). 19.03S, 146.24E, 2mi. ENE of Rollingstone, 26.iv.1969, IC, MU, 1♂ # (ANIC). 20.24S, 148.34E, Greta Ck, 20mi. N of Proserpine, 1.i.1965, GBM, 1♂ (UQ). 21.09S, 148.38E, Finch Hatton Gorge, 19.iv.1968, GBM 1♂ #. 24.12S, 151.47E, Eurimbula Ck, via Round Hill Head, 15.xii.1976, GBM, SRM, 6♂. 25.26S, 152.08E, Mt Goonaneman, via Childers, 6-7.ii.1981, GBM, 1♂ (QM). 25.30S, 151.50E, Bin Bin Ra., 19.xii.1974, H. Frauca, sweeping, 2♂ (ANIC). 25.31S, 152.03E, 10mi. W of Biggenden, 7.i.1972, H. Frauca, 1♂. 26.28S, 152.41E, Imbil, 25.i.1936, F. A. Perkins, 3♂, 3♀ (UQ). 26.38S, 152.58E, Nambour, 14.i.1962, (in house at night), H. Greening, 1♂. 26.42S, 152.54E, Montville, Deane, 1♂, 1♀. 26.46S, 152.51E, Maleny, i.1928, HH, 8♂ (QM, SAM). 27.22S, 152.53E, Samford, 28. ii. 1960, J. Bryan, 1♂ (UQ). 27.28S, 153.02E, Brisbane, 24.ii.1925, HH, 1♂, 2♀ (QM), 3.i.1962, T. Brooks, 1♂ (UQ), 11.i.1965, E. Tay, 1♂, 5.i.1962, K. Barnard, 1♂. Brisbane, UQ Mine site at Indooroopilly, 13.ii.1962, LP, 1♀ (T.71). Brisbane suburbs: (Alderley), 23.i.1957, W. Treloar, 2♂ (QM); (Chelmer), 15.iii.1942, H. Longman, 1♂ (QM); (Indooroopilly), 24.i.1973, T. Lambkin, 1♂. Petrie, 3.ii.1962, J. Akers, 1♂ (T.72, UQ). 27.34S, 153.08E, Tamborine, i.1961, P. Webb, 1♂ (T.69). 27.34S, 151.57E, Toowoomba, 7.i.1964, J. Cardale, 1♂. 28.05S, 153.27E, Burleigh Heads NP, xii.1963, LP, 2 larvae (T.43).

DIAGNOSIS. Males small to medium (4.8-7.6mm long); pronotum orange, MS orange or black; elytra very dark brown, almost black; ventral surface of metathorax, and of abdominal sternites 2-5 black; white light organ (Fig. 20A) occupying all of sternite 6 (lateral margins sometimes dark brown); light organ restricted to median basal area of sternite 7, which is otherwise black; pronotal punctures small, shallow, mostly contiguous; MPP of sternite 7 conspicuously produced, and may be slightly emarginate at apex;

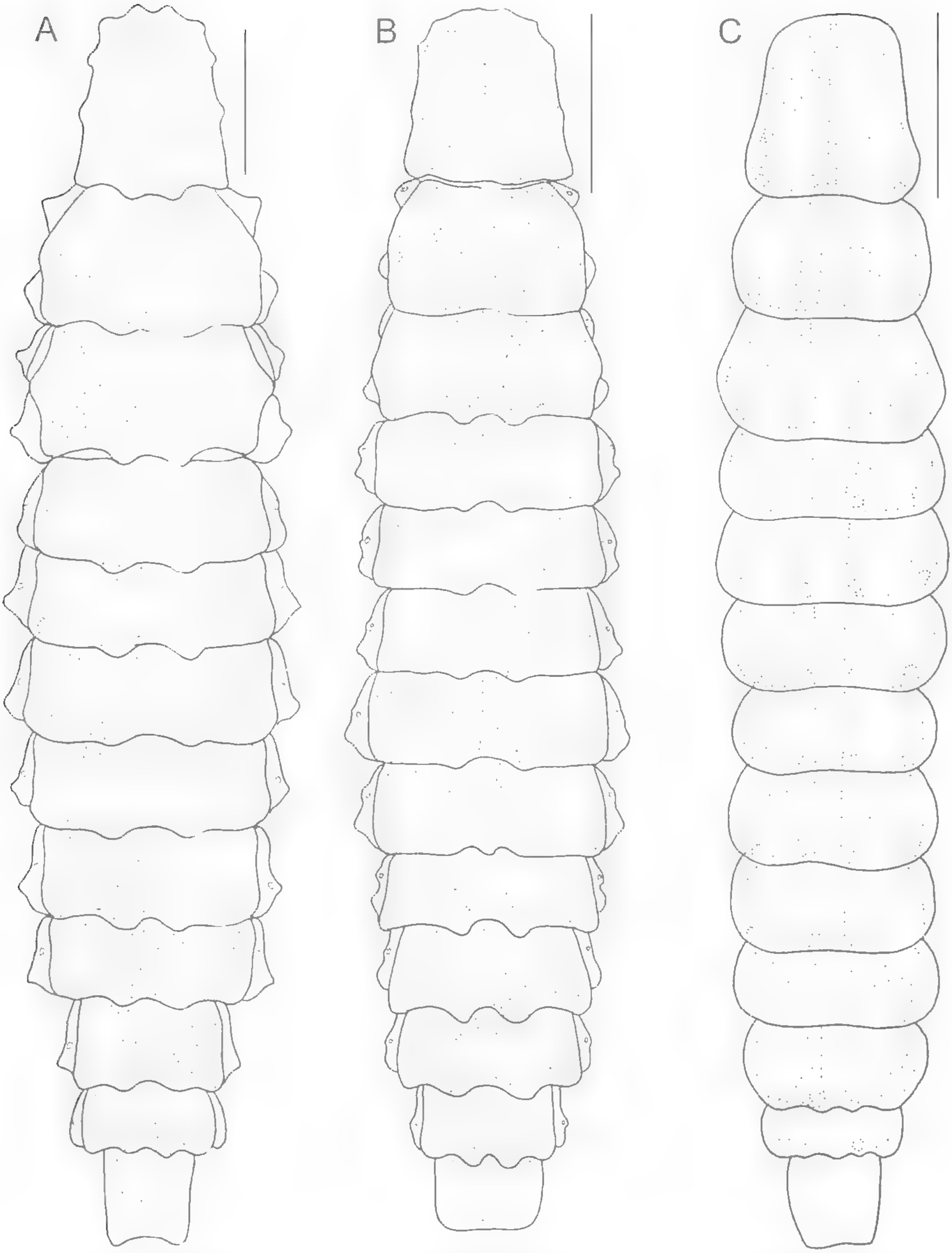


FIG. 22. Larvae of *Luciola* spp., dorsal view. A, *Luciola australis*; B, *L. orapallida*; C, *L. nigra*. Scale lines 1mm.

ventral surface of tergite 8 with lateral ridges but lacking flanges. Female macropterous, coloured as for male except for pale cream light organ in sternite 6. Larva dorsally pale with a broad pale median band.

DESCRIPTION. Males are redescribed; females and larvae are newly described.

Male. 4.8-7.6mm long; pronotum and MN orange yellow, MS orange yellow or black (variability indicated above), elytra black; head, antennae and palpi very dark brown, labrum sometimes paler brown; ventral pro and mesothorax yellow, metathorax dark brown; coxae, trochanters and basal 2/3 of femora of legs 1, 2 yellow orange, remainder dark brown; legs 3 dark brown except for pale trochanters and sometimes pale bases of femora; abdominal sternites 2-5 very dark brown, sternite 6 creamy white, sometimes with narrow dark lateral margins; sternite 7 dark brown except for median basal light organ; all tergites dark brown.

Pronotum 1.2-2.1mm wide, 0.8-1.5mm long; midanterior margin rounded, projecting conspicuously beyond anterolateral angles; lateral margins sub-parallel, or converging slightly posteriorly; punctures small, shallow, mostly contiguous; depressed areas as figured (Fig. 19D).

Elytral epipleuron and sutural ridge evanescent before elytral apex.

Head deeply depressed between the eyes, GHW 1.2-1.8mm; SIW 0.2-0.4mm; ASD < ASW. Antennal flagellar segments 1, 2 subequal, 3 slightly < 2 or 4, 5-9 subequal.

Light organs (Fig. 20A-C) occupying sternite 6 completely except sometimes for a narrow lateral margin, and sternite 7 in median basal area only; MPP of sternite 7 broadly produced, sub-parallel-sided and apically truncate, sometimes slightly emarginate; ventral surface of tergite 8 with lateral ridges and no flanges. Aedeagus (Fig. 21R-T) with basal piece narrow; LL tapering apically, bearing incurving hooks on the ventral surface of their inner apical angles; ML slightly swollen at apex, lacking a median dorsal ridge.

Female. 5.0-7.5mm long; macropterous; coloured as for male except for white light organ in sternite 7, and black sternites 8, 9; small median basal white area, presumed to be fat body, on sternite 8 on females from Crystal Cascades and Coen.

Pronotal lateral margins converging a little both anteriorly and posteriorly, or converging only in posterior 1/3. Median posterior margin of sternite 8 broadly and shallowly indented, of 9 entire.

Larva. (Fig. 22C). Larvae reliably associated. Dorsally brown (often very pale brown), with a broad median pale cream band extending from anterior margin of protergum to posterior margin of antepenultimate tergum; lateral margins of all terga except 1 widely pale; terminal 2 terga pale; venter cream, legs very pale brown.

All terga bearing well defined rounded protuberances (Fig. 22C).

DISTRIBUTION. Widely distributed, often in sclerophyll forest, across Northern Australia and down the east coast of Queensland to Burleigh Heads NP. All records south of Rockhampton have a yellow mesoscutellum (Fig. 25). Ballantyne (1992) recorded this species from New Guinea.

REMARKS. Lea (1929) doubted that *L. scutellaris* was 'other than a variety of *L. humilis* Olivier', because it differed only in having a black mesoscutellum and in the smaller size. While I have found no specimens having black mesoscutellum to approach 7.0mm long (the average length of specimens of *L. nigra*), many smaller specimens (c. 4-5mm) have an orange mesoscutellum. The variability of these features is indicated above; specimens with dark mesoscutellum occur in Queensland from Coen in the north to Rockhampton in the south. Males and females taken together often vary in the colour. A living specimen is shown in Fig. 36D.

L. nigra adults have been found in Brisbane in areas of rainforest or relict rainforest where there is much lantana (e.g. the species was in abundance in the 1960s at the University Mine site at Indooroopilly, and in suburban back yards in the Indooroopilly and St Lucia area). It was collected with *Atyphella scintillans* at the University Mine site, and at Burleigh NP (Powell, 1964), and is frequently taken with *L. flavicollis* (pers. obs.). Armitage's (1908) reference to the 'Queensland firefly beetle' was probably to this species.

Luciola (Luciola) orapallida Ballantyne sp. nov.
(Figs 19, 20, 21, 22)

TYPES. Holotype. ♂ N Qld: 13.57S, 143.12E, Cape York Pen., E coast, Silver Plains: Massey R, 12.xii.1964, salt-water couch, LP (QMT62935). Paratypes: same data, 2♂, 4♀, LP,GBM&JLW (UQ, T.126). Breakfast Ck, in mangroves, 13.xii.1964, JLW, 2♀, 1 larva (T.127). Stewart R, 16.viii.1963, JLW, 5♀. TORRES STRAIT: Saibai I., 10-13.vii.1975, H. Heatwole, 1♀ (AM).

DIAGNOSIS. Male 6.0-7.2mm long; similar to *L. australis F.* and *L. flavicollis* Macleay, distinguished by the broad pale lateral bands on the elytra, the pale colour of the venter and the outline of sternite 7, and the narrow, widely separated aedeagal lateral lobes. Female macropterous, coloured as for male. Presumed larva similar to that of *L. australis.*

DESCRIPTION. *Male.* 6.0-7.2mm long; pronotum, MS and MN orange, elytra brown with wide yellow lateral and sutural margins (Fig. 19F); head, antennae and palpi dark brown; ventral surface of thorax orange; legs yellow except for dark brown tibiae and tarsi; basal 2 abdominal sternites yellow; sternites 3, 4 brown; white light organ in sternites 6 and 7; lateral margins of sternites 6 and 7 narrowly brown, posterior margin of sternite 7 narrowly yellow; all tergites yellow.

Pronotum (Fig. 19E) 1.4-2.1mm wide, 1.1-1.4mm long; midanterior margin rounded, projecting moderately beyond anterolateral angles; lateral margins subparallel or slightly convergent posteriorly; punctures relatively broad, shallow, most separated by their width, few contiguous.

Head deeply depressed between eyes; GHW 1.2mm; SIW 0.3mm; ASD = ASW; FS elongate, subequal.

Light organs (Fig. 20G,H) retracted to anterior half of sternite 7; posterolateral corners of sternite 7 rounded; MPP moderately produced, apically truncate. Ventral surface of tergite 8 with lateral ridges, lacking flanges. Aedeagus (Figs 21O-Q) with narrow basal piece; ML expanded at apex, with median dorsal ridge not serrated; LL widely separated and slightly divergent at their very narrow apices.

Female. 7.2-8.5mm long; macropterous but terminal 2 abdominal segments may protrude beyond elytral apices; coloured as for male except white light organ in sternite 6 and yellow sternites 7 and 8. Pronotum with median anterior margin rounded, barely projecting beyond anterolateral corners; lateral margins converging anteriorly slightly in anterior 2/3, converging slightly posteriorly in posterior 1/3. Head barely depressed between eyes, which are widely separated; mouthparts well developed. Median posterior margins of sternites 8 and 9 not indented.

Larva. (Fig. 22B). Associated by label data only; moderately dark brown on dorsal surface except for pale median line extending from anterior margin of tergum 1 to posterior margin of penultimate tergum; venter of body pale except for brown markings on penultimate segment, and brown terminal segment; legs brown.

Protergum with well-defined protuberances; meso and metaterga with paired midlateral, posterolateral and posterior protuberances; abdominal terga 3-11 with paired posterolateral and posterior protuberances. Distinguished from *L. australis* F. by the absence of well defined protuberances on the anterior margin of the pronotum and the uniformly brown terminal 2 terga.

DISTRIBUTION. Known only from these records in salt water couch on the coastal plain of Cape York Pen. near Coen and on Saibai I. off the S coast of New Guinea (Fig. 23).

REMARKS. The specific name (Latin, *ora* = edge, border; *pallidus* = pale, wan) refers to the pale elytral margins. This new species is superficially similar to *L. flavicollis.* It is presently known from mangrove swamps in Cape York and Torres Strait, while *L. australis* F. is known from mangroves from Gladstone to Cape Pallarenda, just north of Townsville. 'These beetles were found only on damp drift wood, which collects and is left by very high tides during part of every year, mainly towards the end of the dry season. It usually builds up in back washes and bare patches of ground or mud in amongst the 'marine couch'. Driftwood all swept out to sea by high tides during wet season when rivers are in flood. Beetles very quiet and could be picked off debris by hand' (J.L.H. Wassell, pers. comm.).

Pteroptyx s. str. Olivier
(Figs 20, 21)

Pteroptyx Olivier, 1902: 72; 1907: 55; 1909a: 319; 1909b: lxxxii; 1910: 47; 1911b: 16; 1913: 417. Olivier & Pic, 1909: 139. McDermott, 1964: 46; 1966: 117. McDermott & Buck, 1959: 10. Ballantyne & McLean, 1970: 223. Ballantyne, 1987a: 117; 1987b: 171. Calder, 1998: 179.

TYPE SPECIES. Olivier (1902) described *Pteroptyx* from two species, viz. *Luciola testacea* Mots. and *L. malaccae* Gorham, which were characterised by the deflexed elytral apices and the trilobed abdominal sternite 7 in the male. Lucas (1920) designated *L. testacea* as the type species of *Pteroptyx*. Ballantyne & McLean (1970) showed that since *L. testacea* lacked deflexed elytral apices, its taxonomic position is uncertain. It was Olivier's clear intention to erect a genus based on the possession of deflexed elytral apices in the male and all evidence suggests that he never saw Motschulsky's type specimen. Ballantyne & McLean (1970) considered that *L. malaccae* should be proposed to the International Commission for Zoological Nomenclature as the type species, but this has not yet occurred (Calder, 1998).

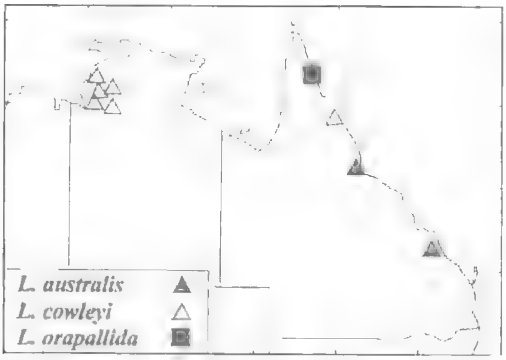


FIG. 23. Records for three species of *Luciola* in northern Australia.

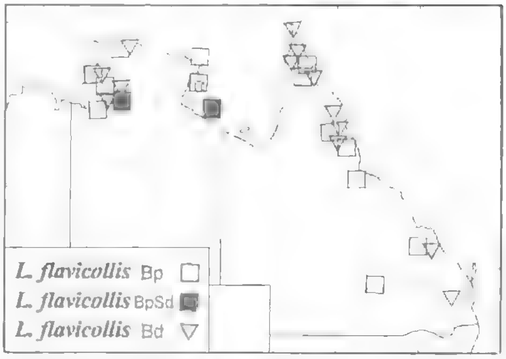


FIG. 24. Records for *Luciola flavicollis* in northern Australia, indicating distribution of elytral colour patterns.

REMARKS. The phylogenetic analysis that follows identifies a *Luciola/Pteroptyx* clade, which clearly distinguishes two Australian species of bent winged fireflies.

KEY TO SPECIES OF *PTEROPTYX* MALES FROM AUSTRALIA

1. Deflexed elytral apex with sides A, B and C subequal (Fig. 20K) . . . . *cribellata* Olivier
   Deflexed elytral apex with sides A and B much longer than C (Fig. 20J) . . . . *platygaster* (Lea)

Pteroptyx cribellata Olivier
(Fig. 20)

Luciola cribellata Olivier, 1892: 1010.
Pteroptyx cribellata Olivier, 1909a: 319. Ballantyne, 1987a: 133. McDermott, 1966: 117 (partim). Ballantyne & McLean, 1970: 242 (partim). Lloyd, 1973a: 991; 1973b: 268; 1979b: 25. Calder, 1998: 179. *Nec* Hanson et al., 1971: 161; Hanson, 1978: 2158; Haneda, 1966: 6; Buck et al. 1981a: 277, 1981b: 287.
Pteroptyx cribellatum Olivier, 1910: 47; 1913: 417. Ballantyne & McLean, 1970: 242 (synonymy).
Pteroptyx cribratellum Pic, 1932: 88. Ballantyne & McLean, 1970: 243 (synonymy).
Nec *Luciola platygaster* Lea. Olivier, 1913: 417 (synonymy). Ballantyne & McLean, 1970: 243.

TYPE. Lectotype. ♂ Papua New Guinea, Ighibirei designated by Ballantyne (1987a) (MCG).

MATERIAL. 5 specimens. QLD: Cape York Pen.: Dividing Ra., 15km W of Captain Billy Ck, 5-12. ii. 1976, GBM, 3 ♂ (synchronous flashing) (QM). 12.44S, 143.17E, Iron Ra., Gordon's Ck, 8.viii.1983, B. Gillies, 1 ♂ (MV). 26.33S, 154.05E, Coolum, 20.iv.1938, 1 ♂ (UQ).

DIAGNOSIS. Orange pronotum, dark brown elytra, tip of deflexed elytral apices truncate; distinguished from other similar species by the dimensions of the deflexed elytral apex (Fig 20K; a, b, c are subequal) and the deep depression in the median area of sternite 7 anterior to the MPP of that sternite (Fig. 20M).

DISTRIBUTION. Specimens listed here extend the range of *cribellata*. The single specimen labelled from Coolum in S Qld is erroneous and requires confirmation.

REMARKS. Olivier (1913) synonymised *Luciola platygaster* Lea with *Pteroptyx cribellata* (Olivier). However they differ by the nature of the deflexed elytral apex.

Pteroptyx platygaster (Lea) comb. nov.
(Fig 20)

Luciola platygaster Lea, 1909: 110. Olivier, 1910: 45.
Nec Pteroptyx cribellata Olivier. Olivier, 1913: 417 (synonymy). McDermott, 1966: 117. Ballantyne & McLean, 1970: 242. Ballantyne, 1987a: 133. Calder, 1998: 180.

TYPES. Calder 1998 interpreted Ballantyne & McLean's (1970) reference to a holotype for this species as a lectotype designation. This designation is confirmed. Lectotype ♂ N Qld: Cairns (SAM). A single ♂ labelled 'Cairns', mounted on a card point with abdomen and aedeagus on separate card point beneath. Paralectotypes, 1♂, 4 ♀ (SAM), 1♂, 1♀ (ANIC, MUMA) designated by Calder (1998) and confirmed here.

MATERIAL. Lectotype, 7 paralectotypes and 87 specimens. N QLD: 12.43S, 143.16E, Middle Claudie R, Iron Ra., 6.x.1974, M. Moulds, 3♀ (AM). 12.43S, 145.38E, Kuranda, F.P. Dodd, 6♂, 4♀ (UQ, SAM). 16.19S, 145.23E, Bamboo Ck nr Miallo, N Mossman, 25.iv.1967, D. Colless, ♂ (ANIC). 16.28S, 145.23E, Mossman, 25.iii.1967, MU, ♂. Mossman Gorge, 300 feet, at light, 31.x.1966, EB, ♂. Cairns, 2♂, 2♀ (SAM); ♂, ♀, H. Carter (ANIC); ♂, 3♀, GB, (ANIC); 3♂, ♀ (MV). Cairns district, J. A. Anderson, 5♂, 5♀ (QM). 17.05S, 145.46E, Meringa, 7♂, 6♀ (SAM, MV). 17.06S, 145.47E, Gordonvale: 5.x.1986, on shrubs, J. Rheinheimer, 1♂, 1♀

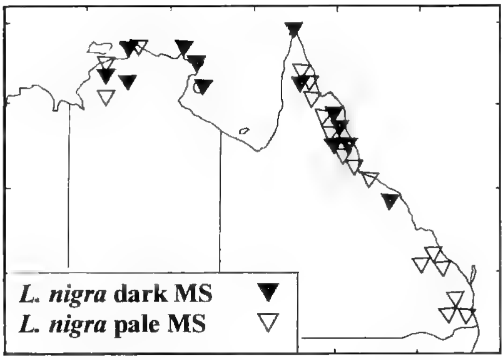


FIG. 25. Records for *Luciola nigra* in northern Australia, showing distribution of mesoscutellum colour.

(ANIC); E. Allen, 1935, 3♂, 2♀ (QM); x.1917, E. Jarvis, ex scrub, 2♂; Gordonvale, Maitland Road, ix.1988, K. Chandler, 6♂, 5♀, on *Acacia* sp. and understory. 17.07S, 145.41E, Little Mulgrave R., HH, 2♀ (AM). 17.07S, 145.47E, Mulgrave R., 4mi. W Gordonvale, 31.xii.1966, DKM, 1♂, 1♀. 17.34S, 145.55E, Coorumba, R. Mulder, 26.iii.1977, 1♀; 15-28.v.1983, 3♂, 6♀.

DIAGNOSIS. One of only two Australian *Pteroptyx*, distinguished from *P. cribellata* by the dimensions of the deflexed elytral apex (Fig. 20J).

DESCRIPTION. Males are redescribed; females are newly described.

Male. 6-8.5mm long. pronotum, MN orange, MS and elytra usually very dark brown, MS sometimes brownish orange; head, antennae and maxillary palpi dark brown, labrum brownish, labial palpi yellow; ventral surface of prothorax yellow, of meso and metathorax brown; legs 1, 2 with yellow coxae and trochanters, remainder dark brown; legs 3 dark brown except for yellow trochanters; basal abdominal sternites dark brown, posterior margin of sternite 5 narrowly pale, and white light organs in sternites 6, 7; all tergites dark brown; dorsally reflexed margins of sternite 6 brown, of sternite 7 white sometimes with small brown patches in anterior fourth.

Pronotum 1.0-1.1mm long, 1.2-1.3mm wide; midanterior margin projecting moderately beyond acute anterolateral angles; lateral margins subparallel, narrowly explanate margins not wider in posterior half; punctures broad shallow, contiguous.

Elytral deflexed apex with sides A and B much longer than side C (Fig. 20J); apex obliquely truncate if viewed from above.

Head deeply depressed between eyes; GHW 1.2-1.5mm; SIW 0.2-0.4mm; ASD > ASW; frons-vertex junction not defined; eye excavation not developed.

Elytral epipleuron continuous to elytral apex; sutural ridge evanescent before apex.

Light organs occupying sternites 6, 7 entirely except for a narrow posterior margin of 7; sternite 7 with dimple, otherwise as described for *P. cribellata* (Fig. 20J). Tergite 8 (Fig. 20L,N) with flanges and lateral ridges similar to *P. cribellata*; aedeagal structure similar to *P. cribellata*.

Female. 6-8mm long. Coloured as for male except MS pale orange or dark brown, light organ restricted to sternite 6 and sternites 7, 8 dark brown. Median posterior margin of abdominal sternite 8 broadly and deeply indented.

REMARKS. Certain Gordonvale specimens (in ANIC) were observed synchronously flashing on and beneath a species of *Acacia* (K. Chandler obs.). 'Flashes were observed at 6-8 second intervals, always with a progressive discharge from one extremity of the bush (usually the top first) over approximately 1 second for the discharge to move around the tree'.

Pyrophanes Olivier

Pyrophanes Olivier, 1885: 368; in Baer, 1886: 132; 1902: 72; 1907: 56; 1911b: 102. McDermott, 1964: 46; 1966: 116. Ballantyne, 1968: 106, 107; 1987b: 173-176. Calder 1998: 180.

TYPE SPECIES. *Pyrophanes similis* Olivier, designated by McDermott, 1966: 116.

DESCRIPTION. MALE. This redescription is based on a generic review of *Pyrophanes* in Ballantyne (1992) and includes morphological characters of non-Australian species.

Dorsal surfaces punctate and clothed in short fine hairs.

Pronotum. W/L 1.7; midanterior margin rounded, usually projecting beyond rounded slightly obtuse anterolateral corners; lateral margins converging anteriorly and posteriorly, or subparallel; lateral margins narrowly explanate, not more widely so in posterior half; posterolateral corners not produced much beyond posterior margin; most of disc smoothly convex, depressed mainly in lateral areas.

Elytra. Punctation not similar to that of pronotum; apices not deflexed; elytra sub-parallel-sided when closed; interstitial lines feebly developed; epipleuron and sutural ridge not extending to elytral apex; elytral apex rounded, not ridged.

Head. Moderately exposed when withdrawn; moderately excavated between eyes; posterolateral eye excavation not developed; GHW about 3 times SIW; labrum transverse; antennal sockets not contiguous, ASD < ASW; frons-vertex junction not defined; eyes widely separated ventrally. Mouthparts well developed; apical segment of labial palpi fusiform, much smaller than apical segment of maxillary palpi. Antennae length subequal to twice GHW or slightly less; 11 segmented; segments simple; scape large, often clavate (Fig. 26I); FS1 subequal in length to pedicel; apex of FS 1 and certain other FS may be produced laterally; all FS except FS1 at least twice as long as wide; apical FS never shortened and club-like, nor produced laterally or flattened.

Legs. MFC present (Fig. 26H); femora 1 and 2 often stout and tibiae 1 and 2 may be curved; femora 3 often enlarged and swollen, and tibiae 3 curved and expanded at their apices (Fig. 26H).

Abdomen. Posterior margin of basal abdominal sternites not recurved. Light organs usually occupying sternite 6 entirely except sometimes for a narrow posterior margin; bipartite (Fig. 26A) in sternite 7, reaching sides but not posterior margin. Sternite 7 MPP short, broad, wider than long and emarginate apically, not upturned or engulfed by the apex of tergite 8; PLP short, narrow and apically rounded; posterior margin between PLP and MPP with a pair of elongate, slender, medially turned lobes bearing hairs on their anterior face only, and paired pointed projections between the lobes and the MPP; a median longitudinal trough is often present between light organ halves; sternite 7 lacks a dimple or median carina and is not swollen or arched in its posterior half; posterior margin densely clothed in fine hairs (not depicted in Fig. 26A). Tergite 8 symmetrical, not shortened, and projecting considerably beyond the MPP; median posterior margin not narrowed or downturned and engulfing the apex of sternite 7; posterior margin medially emarginate; ventral surface (Fig. 26B-D) with a deep median trough which is separated by ridges and flanges from paired lateral troughs bearing anteriorly short spines (area 'a' Fig. 26C) and posteriorly dense hairs (Fig. 26C); medially turned lobes along posterior margin of sternite 7 are below the spined area in resting position.

Aedeagal Sheath. With paraprocts (Ballantyne 1987a: 150, fig. 14a-d). Aedeagus elongate, slender; lateral lobes about 4/5 as long as median lobe, and fused for 1/2-3/4 of their length (Fig. 26E-G).

FEMALE. Known females are macropterous.

LARVA. Lacking laterally explanate margins in *Pyrophanes similis* (Blair, 1927; Bertrand, 1972, 1973).

REMARKS. Olivier (1885) erected *Pyrophanes* for 3 new species, *beccarii*, *appendiculata* and *similis* characterising the male terminal abdomen with a midposterior point or lobe on the terminal sternite. This area is slightly produced (Fig. 26), and apically emarginate, not pointed or lobed. The aedeagal sheath, lying in the median ventral trough of tergite 8, often projects beyond the posterior margin of sternite 7, and is probably Olivier's 'lobe'. Olivier's (1885) plate V, fig.12, and (1907) plate 3, fig. 10 are inaccurate representations of the terminal sternite (Ballantyne, 1992).

McDermott (1964) briefly redescribed *Pyrophanes*: 'may vary toward *Pteroptyx*'. He was probably describing specimens subsequently described as *Pteroptyx macdermotti* McLean (Ballantyne & McLean, 1970). The terminal abdominal segments in *Pyrophanes* are distinctive. McDermott apparently misinterpreted the median visible structure, as had Olivier, and referred to the 'trilobed structure' of the terminal sternite.

An aquatic larva was attributed to *Pyrophanes similis* (Blair, 1927; Bertrand, 1972, 1973).

Pyrophanes beccarii Olivier
(Fig. 26)

Pyrophanes Beccarii Olivier, 1885: 369; 1902: 72; 1907: 56; 1910: 48; 1913: 417.

Pyrophanes beccarii Olivier. McDermott, 1966: 116. Calder 1998: 180.

Luciola complicata Lea, 1921b: 66. Ballantyne in Calder 1998: 180 (synonymy).

TYPES. Holotype. ♂ *Pyrophanes beccarii*: INDONESIA: Aru Islands (MCG). Holotype ♂ *Luciola complicata*: N Qld: 13.52S, 142.51E, Coen R, Cape York Pen. (SAM).

MATERIAL. 2 holotypes and 26 specimens. N QLD: 12.44S, 143.17E, Iron Ra., Cape York Pen., 11-17 May, 1968, GBM, pr in cop (UQ). 12.44S, 143.15E, Claudie R: 2♂ (SAM); 28.i.1914, 2♂ (id as *L. platygaster* by A. Lea), 1♀ (SAM); xi.1912-ii.1913, J. Kershaw, 8♂, 13♀ (MV).

DIAGNOSIS. The only Australian species of *Pyrophanes*, it is distinguished from *P. appendiculata* by its uniformly dark brown elytra and the presence of a lateral expansion of the apex of FS 1.

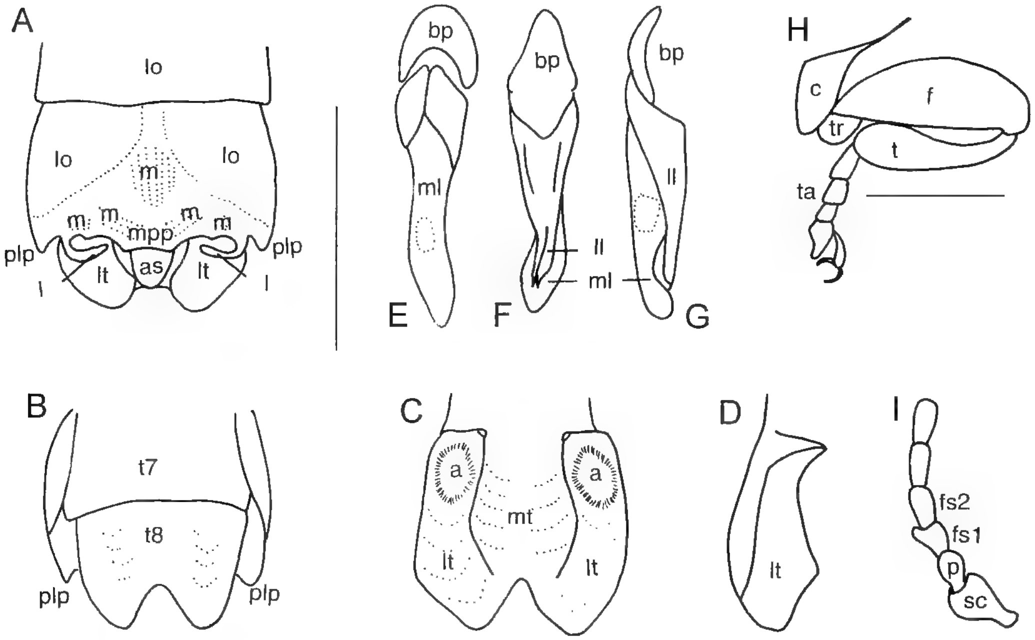


FIG. 26. *Pyrophanes beccarii*, holotype ♂. A,C,D, ventral (A,C) and right lateral (D) aspects of terminal abdominal sternites (A) and tergites (C, D); E-G, aedeagus, ventral, dorsal and left lateral; H, left hind leg, ventral; I, right antenna segments 1-6. Scale lines 1mm; lines shared by: A-G, I. a = area a referred to in text; as = aedeagal sheath; bp = basal piece; c = coxa; f = femur; fs1, 2 = antennal flagellar segments 1, 2; l = lobe of posterior margin of abdominal sternite 7; ll = lateral lobes; lo = light organ; lt = lateral trough of ventral surface of tergite 8; m = muscle; ml = median lobe; mpp = median posterior projection sternite 7; mt = median trough tergite 8; p = pedicel; plp = posterolateral projection sternite 7; sc = scape; t = tibia; ta = tarsus; tr = trochanter; t7, 8 = tergites 7, 8.

DESCRIPTION. *Male*. 6.0-8.0mm long; pronotum, MS and MN pale, semitransparent and yellow; elytra uniformly dark brown in holotype, lateral and sutural margins sometimes finely orange in anterior 1/4 or less; head antennae and palpi brown to black; ventral surface of prothorax yellow, of meso and metathorax brown; legs 1 yellow with brown tibiae and tarsi; coxae, legs 2 and 3 similar, legs 3 sometimes yellow with dark tarsi only; basal abdominal sternites yellow, sternite 5 white or yellow, sternites 6 and 7 white, with light organs confined to sternites 6, 7; posterior margin of sternite 7 golden yellow, ventral surface of tergite 8 yellow; dorsal surfaces of posterolateral projections brown; dorsal abdomen yellow.

Pronotum 1.0-1.2mm long; 1.7mm wide; median anterior margin gently rounded, barely projecting beyond rather acute anterolateral corners; punctures small, shallow, separated by at least the width of a puncture.

Head moderately depressed between eyes; GHW 1.1mm; SIW 0.3mm; ASD < ASW. Antennae (Fig. 26I) with elongate scape, expanded in apical 2/3; pedicel short; FS 1 about as long as pedicel, and produced laterally at apex; FS 2, 3 subequal and slightly expanded at apex; FS 4-9 narrower than FS 1-3; FS 7-9 subequal in length, slightly shorter than FS 4-6; FS 4-9 subequal in width, 4, 5 slightly wider than 6-9. MFC present (Fig. 26H); no specimen shows equal numbers of teeth on both legs, probably as they have broken off; a maximum of 10 teeth was observed on one leg of one specimen; hind femora swollen and slightly curved, hind tibiae curved and swollen at apex (Fig. 26H).

Light organs occupying sternite 6 entirely and bipartite in sternite 7 (Fig. 26A); median ventral face of sternite 7 with median trough and muscle attachments clearly visible through semi-transparent cuticle; ventral surface of tergite 8 (Fig. 26C,D) with area 'A' oval, concave, surrounded by short fine hairs and densely covered with very short semitransparent spines; area 'A' occurs immediately above the medially turned lobes of sternite 7; area 'B' densely clothed with short fine hairs. Aedeagus asymmetrical, with short lateral lobes (Fig. 26E-G).

Female. 5.5-7.0mm long; coloured as for male except venter of body yellow - light brown, white light organ in sternite 6 only and sternites 7, 8 yellow; antennae with FS 1 short, slightly longer than pedicel and not produced laterally; posterior margin of penultimate abdominal sternite broadly excavated; median posterior margin of sternite 9 not excavated.

DISTRIBUTION. In Australia this species occurs only in the central part of Cape York Pen. (Fig. 27).

REMARKS. The function of the developments along the posterior margin of sternite 7 is not known, but certain pinned specimens have this margin, excluding the PLP, inclined vertically such that if the specimen is viewed from beneath the posterior margin of this sternite appears to be entire; in this situation the incurving lobes are adjacent to the spined area of the lateral troughs.

SPECIES INCERTAE

Luciola (Luciola) incerta (Boisduval)

Lampyris incerta Boisduval, 1835: 124. Calder, 1998: 180.
Colophotia incerta Dejean, 1837: 104 (catalogue name only).
Luciola incerta (Boisduval). Olivier, 1902: 80.
Luciola (Luciola) incerta (Boisduval). McDermott, 1966: 106.

TYPE. New Holland, not found at MNHP by LB in November 1993.

REMARKS. The described dorsal colour approaches that of *L. dejeani* and *L. costata*. The ventral colouration approaches *dejeani*.

Lampyris serraticornis Boisduval

Lampyris serraticornis Boisduval, 1835: 124; McDermott, 1966: 123. Calder, 1998: 180.

TYPE. New Holland location unknown, not found at MNHP by LB in November 1993.

REMARKS. The described dorsal colour approaches that of *L. dejeani* and *L. costata*.

CLADISTIC ANALYSIS

MISSING DATA. Many authors have discussed computer interpretation of missing data in phylogenetic analyses in the last 10 years. The ready availability of computers to handle such information has led to the widespread use of '?' for not only missing data, but also inapplicable and polymorphisms. Few systematists still use '?' coding for polymorphisms as computer programs are now available that allow polymorphic scoring for taxa. Phylogenetic analyses of data matrices containing large numbers of missing data have been reported in recent times because of the inclusion of: fossils (Gauthier et al., 1988; Messenger & McGuire, 1998; Skevington & Yeates, 2000; Wilkinson, 1995) for which molecular, developmental and many morphological characters cannot be scored; behavioural knowledge (Carpenter, 1987); and molecular data (Chavarria & Carpenter, 1994). One gender of several taxa may be unknown (e.g. Yeates & Lambkin, 1998) and cannot be included in morphological data matrices. This data disjunction (Nixon & Carpenter, 1996), which occurs when there is missing data for characters in the terminal taxa being compared, creates considerable problems in phylogenetic analyses by increasing the number of solutions and reducing the data decisiveness (Goloboff, 1991) of the resulting most parsimonious trees (Nixon & Carpenter, 1996).

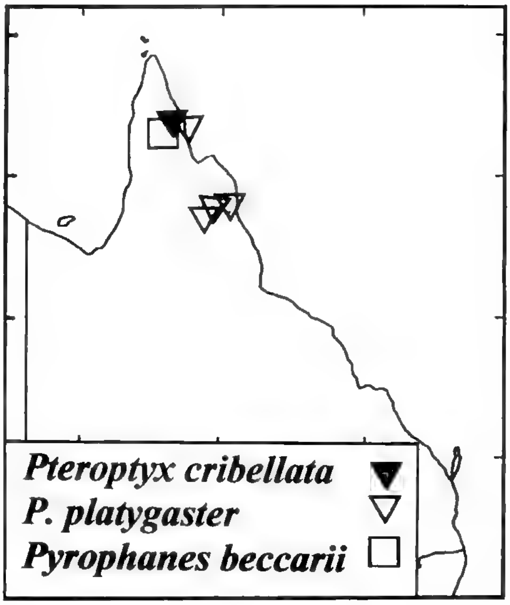


FIG. 27. Records of *Pteroptyx* and *Pyrophanes* in far north Queensland.

Cladistic programs assign states to taxa missing data, based on the most parsimonious distribution of known characters (Novacek, 1992). However large numbers of missing values concentrated in terminal taxa may result in terminal taxa being placed in radically different positions on most parsimonious trees, or trees unstable to the addition of new data (Nixon & Carpenter, 1996), with the resultant strict consensus tree totally unresolved (Carpenter, 1987). Large numbers of missing entries in certain taxa may force taxa into 'branch swapping eddies' that generate huge numbers of most parsimonious trees and decrease resolution of the cladogram (Novacek, 1992). Initial cladistic analyses for 43 species of the Luciolinae exceeded the phylogenetic program limit for the number of most parsimonious trees that could be saved. This problem is due to the large proportion of missing larval and female data in the matrix. Larval features alone (8 characters) are missing for 19 taxa, and female and larval features (up to 16 characters) are missing for a further ten taxa. The removal of nine taxa, for which both the larvae and females are unknown, significantly decreased the numbers of most parsimonious trees.

The removal of taxa with considerable amounts of missing data is contraindicated because poorly represented taxa may still include novel combinations of characters that are important for correctly reconstructing the phylogeny, and contain information on the structure of the tree that cannot be retrieved from the rest of the data matrix (Novacek, 1992). Relationships among terminal taxa are not only affected by the amount of missing data, but also by the relative distribution of that data (Wilkinson, 1995, 1997). Wilkinson (1995) considered the situations where taxa with large numbers of missing values could be safely removed from the analysis, without affecting inferred relationships, tree lengths, or consistency indices. Safe taxonomic reduction involves the removal of taxonomic equivalents (Wilkinson,1995), taxa with missing characters that do not differ with respect to phylogenetically informative characters. No taxonomic equivalents were found in the data matrix, but two taxa missing all female and larval features, differed in only a single homoplasious character from other taxa. Removal of only these two near taxonomic equivalent taxa decreased the number of most parsimonious trees and allowed relationships to be inferred from 41 taxa in four genera of the Luciolinae.

TERMINAL TAXA. There has been no previous attempt to analyse Luciolinae phylogeny using the methods of cladistics. We attempted this analysis as a precursor to further taxonomic work on this fauna, as any analysis on the Australian fauna alone, given that none of the genera is endemic, would yield little information about relationships. The Luciolinae genera and subgenera are presented here largely in the form devised by McDermott (1966).

Specimens of 43 taxa of the Luciolinae were coded for morphological features which clearly distinguished species, groups of species, or genera (Table 1). This analysis included all the Australian species plus a wider taxon sampling of the Luciolinae based where possible on the type species of each genus and subgenus. Alternatively genera were scored from a representative species for which specimens were accessible and/or published information exists. LB scored all but *Photuroluciola* Pic, which was not reliably identifiable in collections. Australian species are indicated by * in Table 1 and Figs 30 and 33. Subgenera are enclosed in parentheses.

A representative collection of New Guinean species considered by Ballantyne (1992) to be closely related to the Australian fauna was included, and two distinctive but as yet unnamed groups from New Guinea code named 'Sisiak' (= '*Luciola* species 12' in Ballantyne, 1987b: 185, fig. 1c-f) and 'MtMissim'. A single female of the latter was described by Ballantyne (1968: 122, figs 130-132, 134) as possibly belonging to *Luciola* (*Pygoluciola*); the species is now known from a single male (Ballantyne, 1992). Also included were certain non-Australian *Pteroptyx* as a basis for comparison with the Australian and New Guinean bent-winged fireflies (Ballantyne & McLean, 1970; Ballantyne 1987a, 1992). Information on non-Australian species presented here is supported by published work (Ballantyne, 1968, 1987a,b; Ballantyne & McLean, 1970; Ballantyne & Buck, 1979) as well as recent examinations. With two exceptions LB examined and dissected reliably identified museum specimens of every non-Australian species recorded specifically for this purpose (specimens are housed in BMNH and ANIC). *Luciola (Pygoluciola) stylifer* and *Pteroptyx macdermotti* are represented by a very few specimens and were scored from published or thesis descriptions only (Ballantyne, 1968, 1987a, 1992). We have included some non-Australian species of *Atyphella*, a genus that extends to New Guinea and neighbouring islands but whose range is not yet defined. McDermott (1964, 1966) did not recognise the genus and in 1966 transferred all these species to *Luciola* subgenus *Luciola*. Ballantyne in Calder (1998) reassigned *Atyphella* to generic level based on seven Australian species including *majuscula* Lea which was transferred from *Luciola*. Nine species currently contained in *Atyphella* are included in our phylogenetic analysis of the Luciolinae.

As all other subfamilies have seven visible abdominal segments in the male, any genus outside the Luciolinae could have served as an outgroup. An undescribed species of a South American *Photuris* was chosen as it has been the subject of recent investigation (Ballantyne, 1992; Lloyd & Ballantyne, in prep.).

We excluded nine species, *Atyphella brevis*, *A. ellioti* sp. nov., *A. flammulans* sp. nov., *A. immaculata* sp. nov., *A. monteithi* sp. nov., *Luciola (Luciola) carolinae*, *L. cowleyi*, *L. dejeani* and *L. (Pygoluciola) stylifer* from two analyses because all female and larval characters are unknown for these taxa.

Atyphella brevis and *A. flammulans* sp. nov. were removed from one analysis because, while missing all female and larval characters, they differ from other taxa by only a single homoplasious, but informative, character.

DATA ANALYSIS. Phylogenetic analyses presented here use the method of cladistics (Hennig, 1966; Farris, 1983). We do not prejudge the relative informativeness of characters nor exclude characters because of their perceived level of homoplasy (Larson & Dimmick, 1993).

Cladistic analyses were performed with polymorphic characters interpreted as 'partial uncertainty'. PAUP chooses a state from the set of available states that allows minimisation of the tree length (Swofford, 1993).

We performed parsimony-based phylogenetic analyses with heuristic searches of the data using 10 random step-wise addition sequences, tree-bisection-reconnection (TBR) branch swapping, MULPARS and branches having maximum length zero collapsed to yield polytomies in effect, using PAUP version 3.1.1 and PAUP* versions 4.0b1a (68K no FPU) and 4.0b2 (Swofford, 1998). These versions of PAUP have a tree-save limitation of 32,676 most parsimonious trees. When this limitation was reached the analysis was repeated using the 'nchuck' command in PAUP to save only 30,000 trees less than, or equal to, a specified length before moving to the next random addition sequence. Strict and semistrict consensus (Bremer, 1990) of the most parsimonious trees were computed using PAUP. Where specified, analyses were repeated using Hennig86 ver. 1.5 (Farris, 1988). The command mh* was used to find initial trees. The trees retained were then passed to the extended branch swapper, bb*. Figures 30-34 were prepared using PAUP, and Fig. 35, showing characters and character states upon a most parsimonious tree, was prepared with CLADOS version 1.2 (Nixon, 1992) with DELTRAN optimisation.

Successive approximations character weighting (successive weighting) was used as a guide to choose between most parsimonious trees (Farris, 1969; Carpenter, 1988). This is an iterative character weighting procedure in which weights are assigned based on their observed level of homoplasy. Initial weights are derived from the most parsimonious trees under equal weighting, and subsequent heuristic searches completed based on the rescaled consistency index (Farris, 1989). The procedure is repeated until the weights (and trees) remain stable over iterations. Successive weighting of the most parsimonious trees was computed using PAUP with a base weight of 1000.

Bremer support (Kallersjö et al., 1992) to indicate character support for nodes on the cladogram was calculated using the computer program TreeRot (Sorenson, 1996). As tree-save limitations were likely to affect calculation of Bremer support, support values were conducted on the data matrix for 42 taxa with polymorphisms removed. Figure 34A indicates support values calculated on the first saved most parsimonious tree. Figure 34B indicates successively weighted support values (Bremer, 1994) calculated on the first saved, successively weighted tree.

CHARACTER ANALYSIS. Characters are numbered according to sequence in the data matrix and designated states are numbered to the right. The matrix of taxa and assigned character states is given in Table 1.

ADULT MALE MORPHOLOGY (CHARACTERS 1-88)

Pronotum (1-9)

1. Hypomera. ***0***. open. ***1***. closed in front.

2. Lateral pronotal margins. ***0***. diverging along anterior half or more with some convergence in posterior area (Fig. 1A-D,F,G,I-L). ***1***. Subparallel or wider across middle with slight convergence anteriorly and posteriorly. ***2***. diverging along their length (Ballantyne & McLean, 1970 fig. 4c). ***3***. converging posteriorly along their length (Fig. 19A). In states 0 and 2 the pronotum is wider across the base than across the middle; in state 1 it is wider across the middle than across the base.

3. Anterolateral corners of pronotum. ***0***. obliterated (McDermott & Buck 1959, fig. 38). ***1***. rounded obtuse (Fig. 1, 19A-E). ***2***. pointed (Ballantyne, 1968 fig. 130). ***3***. acutely rounded (Ballantyne 1968, fig. 120).

4. Degree of head exposure in front of pronotum. ***0.*** greatly exposed. ***1.*** scarce to moderately exposed. ***2.*** concealed.
The head is either greatly exposed in front of the pronotum (when the head cannot be retracted beneath the pronotum), slightly exposed (when at least some of the posterior section of the head is retracted beneath the pronotum at rest) or concealed (not visible from above).

5. Posterolateral corners of pronotum. ***0.*** rounded obtuse (Fig. 1A-C,D,F-G,I,J-L). ***1.*** right angled or angulate obtuse. (Fig. 19C-E; Ballantyne & McLean 1970, fig. 4H). ***2.*** rounded acute. ***3.*** broadly pointed (Ballantyne, 1968 fig. 120). ***4.*** narrowly pointed (Ballantyne, 1968 fig. 130).

6. Posterolateral corners of pronotum. ***0.*** scarcely projecting beyond posterior margin nor delimited by a deep emargination of the posterior margin. ***1.*** projecting considerably beyond posterior margin and often delimited by an emargination of the posterior margin (Ballantyne, 1968 figs 20, 33, 38, 51, 62, 70).

7. Lateral margin of pronotum near posterolateral corner. ***0.*** not indented. ***1.*** slightly indented.

8. Lateral margin of pronotum. ***0.*** not flattened. ***1.*** flattened only in posterior half. ***2.*** all of lateral margin narrowly flattened but not more so in posterior half. ***3.*** all of lateral margin narrowly to widely flattened but more so in posterior half of pronotum. ***4.*** lateral margin widely flattened along its length and anterior area as wide as or wider than posterior area.

9. Anterior margin of pronotum. ***0.*** not explanate. ***1.*** narrowly explanate.

Elytron (10-17)

10. Punctation. ***0.*** not conspicuously larger than pronotal punctation. ***1.*** conspicuously larger than pronotal punctation.

11. Apex. ***0.*** not deflexed. ***1.*** deflexed with apex rounded (Fig. 20J,K).

12. Apex. ***0.*** not deflexed. ***1.*** deflexed with sides A, B, C equal (Fig. 20K). ***2.*** deflexed with sides A, B longer than C (Fig. 20J).

13. Development of epipleuron and sutural apex in apical half of elytron. ***0.*** no thicker than rest. ***1.*** considerably thicker than anterior portions.

14. Interstitial lines. ***0.*** 2-4 well defined lines. ***1.*** one only defined line (line 3). ***2.*** no lines well defined.

15. Epipleuron. ***0.*** extending to apex of elytron. ***1.*** extending past mid point of elytron but not to apex 1. ***2.*** extending no further than mid point of elytron.

16. Sutural ridge. ***0.*** extending to apex of elytron. ***1.*** evanescent before elytral apex.

17. Margins. ***0.*** parallel sided. ***1.*** convex sided.

Head (18-39)

18. Depression of vertex. ***0.*** minimal. ***1.*** moderate-deep.

19. Approximation of eyes on ventral surface of head (measured as eye separation taken just behind mouthparts/GHW measured ventrally). ***0.*** wide separation (0.5 or greater). ***1.*** close to moderate separation (0.4 or less). ***2.*** contiguous or almost so.

20. Posterolateral eye excavation (Ballantyne, 1968 figs 144, 147-150). ***0.*** absent; if slightly developed not visible when head is retracted. ***1.*** well developed and usually visible even when head is evenly retracted.
A well developed posterolateral eye excavation is at least as wide as long when viewed from the side.

21. Antenna length. ***0.*** much longer than twice GHW. ***1.*** > GHW - 2 × GHW. ***2.*** subequal to GHW.

22. Proximity of antennal sockets. ***0.*** contiguous. ***1.*** separated by < 2 × ASW but not contiguous. ***2.*** separated by at least 3 × ASW.

23. Frons-vertex junction. ***0.*** not acute (Fig 2A,D,H). ***1.*** acute (Fig. 2C,F,G,I).

24. Median area of frons vertex junction. ***0.*** not elevated or indented. ***1.*** elevated and/or indented (Fig 2F, G).

25. Anterior margin of head. ***0.*** not prolonged. ***1.*** prolonged in front of eye for about its width (Ballantyne, 1968 figs 132, 134).

26. Labrum. ***0.*** approximately twice as wide as long. ***1.*** about as long as wide.

27. Clypeolabral suture. ***0.*** flexible. ***1.*** inflexible, visible. ***2.*** inflexible and invisible (Ballantyne, 1968 figs 132, 134).
John Lawrence (ANIC Canberra) interpreted the nature of the labrum and clypeus on specimens of *Photuris* and "Mt Missim'.

28. Mouthparts. ***0.*** functional. ***1.*** non functional.
Non functional mouthparts have very small apical segments of labial and maxillary palpi, mandibles often do not cross in the median line and the antennal sockets are contiguous.

29. Proximity of eyes above labrum (SIW/GHW). ***0.*** close (1/6-1/15). ***1.*** moderately separated > 1/6. ***2.*** widely separated 1/3 - 1/2.

30. Antennal flagellar segment 1. ***0.*** as long as or longer than pedicel. ***1.*** shorter than pedicel.

31. Apex of antennal flagellar segment 1. ***0.*** not expanded at its outer apex. ***1.*** expanded at its outer apex.

32. Median area of antennal flagellar segment 1. ***0.*** not produced. ***1.*** produced (Ballantyne & McLean, 1970 fig. 18b).

33. Flagellar segments 7-9. ***0.*** not conspicuously shorter than rest of FS. ***1.*** conspicuously shorter than rest of FS.

34. Number of segments. ***0.*** 11. ***1.*** < 11

35. Flagellar segment 9. ***0.*** apically rounded. ***1.*** apically pointed.

36. Flagellar segments 2-8. ***0.*** not expanded. ***1.*** expanded at anterior apical angle.

37. Antennal segments. ***0.*** not flattened. ***1.*** flattened.

38. Pedicel. ***0.*** not produced at outer apex. ***1.*** produced at outer apex.

39. Shape of labial palpi. ***0.*** fusiform or about as wide as long with inner margin entire. ***1.*** dentate, laterally flattened. ***2.*** lunate, inner margins entire.

Legs (40-45)

40. Inner tarsal claw of each leg. ***0.*** not split. ***1.*** split.

41. Metafemoral comb (Ballantyne, 1987a fig. 1j). ***0***. absent. ***1***. present.

42. Femora 3 (Ballantyne & McLean, 1970 fig. 4P). ***0***. not swollen. ***1***. swollen.

43. Curvature of femora 3. ***0***. not curved. ***1***. curved along their length (Fig. 26H).

44. Swelling of tibiae 3. ***0***. not swollen. ***1***. swollen at least at their apices (Fig. 26H).

45. Curvature of tibiae 3. ***0***. not curved. ***1***. curved (Fig. 26H).

Abdominal Sternites (46-62)

46. Sternite 8. ***0***. present. ***1***. absent.

47. Light organ in sternite 7. ***0***. entire (e.g. Fig. 4A). ***1***. posterior medial division short - long. (Ballantyne, 1968 fig. 42, 91). ***3***. bipartite (Fig. 26A).

48. Light organ in sternite 7. ***0***. reaching sides and posterior margin of sternite 7. ***1***. reaching sides but not posterior margin. ***2***. not reaching sides or posterior margin.

49. Size of light organs. ***0***. occupying at least half of the area of sternite 7 or more. ***1***. restricted to very small paired anterolateral plaques that occupy less than 10% of the area of sternite 7. (Ballantyne & McLean, 1970 fig. 18C).

50. Apex of MPP of sternite 7. ***0***. MPP not developed. ***1***. apex truncate. ***2***. apex rounded. ***3***. apex gently emarginate (e.g. Fig. 20D,F,J,K,I). ***4***. apex deeply emarginate (Fig. 3D,E,G,J; Ballantyne, 1968 fig. 13).

51. Length/width of MPP of sternite 7. ***0***. not produced. ***1***. about as long as broad or shorter; narrower than half the width of sternite 7. ***2***. about as long as broad; at least half as wide as sternite 7. ***3***. at least twice as long as wide.

52. MPP of sternite 7. ***0***. not engulfed (e.g. Fig. 4A). ***1***. partially engulfed and surrounded laterally by the slightly downturned apex of tergite 8. (Ballantyne, 1968 figs 5, 9, 26, 91). ***2***. engulfed by the down turned apex of tergite 8 completely (Ballantyne, 1968 figs 18, 107-109, 111, 113).

53. Median longitudinal carina in sternite 7. ***0***. absent. ***1***. present (Ballantyne & McLean, 1970 fig. 3D,F).

54. Median longitudinal trough in sternite 7. ***0***. absent. ***1***. present.

55. Median longitudinal trough on ventral surface of MPP. ***0***. absent. ***1***. present (Ballantyne & McLean, 1970 fig. 3D, F).

56. All of sternite 7, especially in posterior half. ***0***. flat, not arched or swollen (e.g. Fig. 4A). ***1***. arched and often swollen (Ballantyne, 1968 figs 56, 89).

57. Length of PLP of sternite 7. ***0***. not developed. ***1***. slightly produced (Fig. 26A). ***2***. moderately produced, may extend beyond the tip of the MPP. ***3***. considerably produced (Ballantyne 1987b, fig. 2A, B).

58. Width of PLP of sternite 7. ***0***. not developed. ***1***. narrower than MPP (Fig. 26A). ***2***. as wide as MPP (Ballantyne & McLean, 1970 fig. 9A,B). ***3***. broader than MPP (Ballantyne, 1987b fig. 2A,B).

59. Inclination of PLP of sternite 7. ***0***. not developed. ***1***. horizontal. ***2***. oblique - vertical (Ballantyne & McLean, 1970 fig. 3D, F; Ballantyne, 1968 figs 11, 13).

60. Incurving hairy lobes along posterior margin of sternite 7 (Fig. 26A). ***0***. absent. ***1***. present.

61. Pointed projection of sternite 7 posterior margin (Fig. 26A). ***0***. absent. ***1***. present.

62. Dimple on sternite 7 (Fig. 20K). ***0***. absent. ***1***. present.

Abdominal Tergites (63-69)

63. Ventral face of tergite 8. ***0***. lacking flanges. ***1***. with symmetrical flanges (Fig. 20I). ***2***. with asymmetrical flanges.(Ballantyne, 1987a fig. 13R).

64. Ventral face of tergite 8 with depressed lateral troughs (Fig. 26C,D). ***0***. absent. ***1***. present.

65. Ventral face of tergite 8 with elongate longitudinal symmetrical developments margining a median longitudinal trough. ***0***. absent. ***1***. fine transparent barely elevated ridges margining a median longtitudinal trough. ***2***. slightly thickened barely elevated ridges margining a median longtitudinal trough. ***3***. low barely elevated ridges present in posterior half of ventral surface only. ***4***. longtitudinal raised well developed ridges delimiting a median longitudinal trough.

66. Ventral face of tergite 8 with asymmetrical projections (other than flanges), and/or transverse ridges and/or hooks. ***0***. absent. ***1***. present (Ballantyne, 1987b fig. 2F).

Ballantyne 1987b termed all the narrowed ventral projections of tergite 8 'flanges'. Flanges are here interpreted as the narrowed anterior projections often of lateral longitudinal ridges on the ventral surface of tergite 8.

67. Bifurcate anterior margin of tergite 8. ***0***. about as long as or no longer than entire posterior (visible) part of tergite. ***1***. at least 3 times as long as entire posterior visible part of tergite.

68. Width of tergite 8. ***0***. about as wide as long. ***1***. very short. ***2***. much longer than wide and projecting considerably beyond MPP.

69. Width of posterior half of tergite 8. ***0***. not narrowed, or lateral margins converging but not abruptly. ***1***. abruptly narrowed (Ballantyne, 1968 figs 17, 110, 112, 114).

Aedeagal Sheath (70-73)

70. Symmetry of aedeagal sheath sternite. ***0***. symmetrical in posterior half (Fig. 21B,D,E). ***1***. asymmetrical in posterior half (Fig 21I).

71. Length/width of aedeagal sheath. ***0***. never more than about 4 times as long as wide. ***1***. very long and narrow (about 7 times as long as wide).

72. Lateral margins of aedeagal sheath. ***0***. lacking paraprocts (Fig. 21C,D). ***1***. with paraprocts (Fig. 21A,B).

73. Length/width of tergite 9 of aedeagal sheath. ***0***. about as long as wide. ***1***. much wider than long.

Aedeagus (74-84)

74. Maximum width across lateral lobes/ maximum width of median lobe. ***0***. wide (4 – 6/1) (Ballantyne 1968, fig. 171). ***1***. moderate (2/1) (Fig. 5). ***2***. narrow (less than 2/1) (Fig. 21O,R,U; 26E).

75. Inclination of apex of median lobe. ***0***. not curving ventrally. ***1***. curving ventrally (Ballantyne, 1968 figs 164, 168).

76. Extent of preapical ventral area of median lobe. ***0***. not produced. ***1***. produced and rounded. ***2***. produced and pointed (Ballantyne, 1968 figs 162, 164, 168).

77. Length of median lobe of aedeagus relative to lateral lobes. ***0.*** much shorter than LL. ***1.*** subequal in length to lateral lobes or slightly longer. ***2.*** longer than LL but less than twice their length. ***3.*** much longer than LL i.e. more than twice their (separated) length.

78. Separation of lateral lobes of aedeagus. ***0.*** separated for > half their length. ***1.*** separated for less than half their length (Fig. 26E-G).

79. Width of lateral lobes of aedeagus. ***0.*** wider and flatter at apices than widest point of ML (Fig. 21L, M). ***1.*** about as wide at apices as widest point of ML (Fig. 5). ***2.*** narrower at apices than ML widest point (Figs 21P, S,U,V; 26E-G).

80. Separation of lateral lobes into broad basal section and narrowed widely separated apical section. ***0.*** no such separation. ***1.*** present (Fig. 21K).

81. Aedeagal symmetry. ***0.*** symmetrical. ***1.*** asymmetrical (Fig. 26E, F).

82. Fleshy lobes on lateral lobes. ***0.*** absent. ***1.*** present as short rounded projections (Fig. 21K). ***2.*** present as elongate leaf like lobes (Fig. 21L,N).

83. Extent of ventral face of apices of lateral lobes. ***0.*** beyond sides of ML, visible from beneath (Figs 5, 21K-M). ***1.*** not beyond ML sides, invisible from beneath (Figs 21O, P,R,S,U,V; 26E-G).

84. Lateral appendages of lateral lobes. ***0.*** absent. ***1.*** present (McDermott & Buck 1959, fig. 62A-C; McDermott, 1962 fig. 1A-C).

Male Colour Patterns (85-88)

85. Colour of pronotum. ***0.*** pronotum concolourous. ***1.*** pronotum with dark markings.

86. Colour of elytral margins compared to rest of elytra. ***0.*** elytra concolourous (dark – light brown). ***1.*** if elytron dark then only lateral margin pale. ***2.*** lateral and sutural margins pale at least in basal half. ***3.*** lateral and sutural margins pale with base of elytron dark. ***4.*** lateral sutural and apical margins pale, base of elytron pale. ***5.*** if elytron pale then darker markings scattered at base and apex. ***6.*** if elytron pale then dark markings at apex only. ***7.*** elytra concolourous (pale).

87. Colour of interstitial lines 1, 2 as distinct from basal elytron colour or colour of its margins. ***0.*** no paler than dark area between lines 1 and 2. ***1.*** about as pale or slightly paler. ***2.*** distinctly paler than this area so I lines appear as stripes.

88. Colour of terminal abdominal tergum. ***0.*** as dark as or darker than preceding terga. ***1.*** pale (as pale as preceding terga or paler).

Adult Female Morphology (89-96)

89. Development of fore wings of female. ***0.*** fully developed (or covering all but two abdominal segments). ***1.*** elytra longer than pronotum but shortened such that they cover approximately 1/2-2/3 of the abdomen. ***2.*** elytra shorter than pronotum (more than half as long as pronotum) and contiguous in the median line. ***3.*** elytra shorter than half pronotal length and often contiguous or closely approaching in the median line. ***4.*** elytra shorter than half pronotal length and widely separated in the median line. Macropterous gravid females may have one to two abdominal segments protruding beyond the elytral apices.

90. Development of hind wings of female. ***0.*** fully developed. ***1.*** hind wings about 2/3 as long as macropterous state. ***2.*** hind wings vestigial or absent.

91. Extent of female light organ. ***0.*** occupying sternites 6 and 7. ***1.*** restricted to sternite 6.

92. Colour of pronotum. ***0.*** pronotum concolourous. ***1.*** pronotum with coloured markings.

93. Colour of elytra. ***0.*** elytra concolourous. ***1.*** elytra not.

94. Number of elytral interstitial lines. ***0.*** four. ***1.*** less than 4.

95. Nature of pronotal punctures. ***0.*** contiguous in at least lateral areas. ***1.*** not contiguous in any area.

96. Head form. ***0.*** of winged female form (Fig. 6B). ***1.*** of wingless female form (Fig. 6D, E).

Larval Morphology (97-104)

97. Production of lateral margins of terga. ***0.*** lateral margins not explanate (Fig. 22). ***1.*** lateral margins narrowly explanate especially at posterolateral corners (Ballantyne, 1968 figs 158-160). ***2.*** lateral margins widely explanate (Figs 12, 15).

98. Length/width of pronotum. ***0.*** longer than wide. ***1.*** about as long as wide.

99. Nature of tergal margins. ***0.*** not ridged. ***1.*** ridged.

100. Paired dorsal and ventral tubercles on protergum. ***0.*** absent. ***1.*** present (Fig. 15A,C).

101. Shape of posterolateral corners of protergum. ***0.*** rounded (Fig. 15A-C). ***1.*** acute (Fig. 12C). ***2.*** narrowly produced.

102. Margins of median line on terga 1-10. ***0.*** not ridged. ***1.*** ridged.

103. Size of punctures in anterior half of terga 2-10. ***0.*** no larger than rest. ***1.*** larger than rest.

104. Extent of posterolateral corners of tergum 11. ***0.*** not produced (Fig. 7A, 15B). ***1.*** produced (Fig. 12A-C, 15A,C).

CHARACTER DESCRIPTIONS. The data matrix (Table 1) describes 104 characters for 44 taxa. Many taxa were coded missing, '?', because females and/or larvae are unknown for many species. Larval characters alone (8 characters) are missing for 19 taxa, all female and larval characters (total of 16 characters) are missing for a further 9 taxa, and 14 female and larval characters are missing for one further taxon. Thirty-four characters are multistate; 23 have three states, 6 four states, 5 five states, and one character has eight states. Multistate characters 4, 14-15, 19, 21-22, 27, 29, 48, 52, 57-58, and 89-90 were treated as additive as they include states describing linear variation of size or development. The data matrix includes polymorphic coding (characters with more than one state observed in specimens of a taxa) for 14 taxa and seven characters. The minority state is indicated

TABLE 1. Data matrix describing 104 characters for 44 taxa including polymorphic coding. The minority state is indicated by placement in a separate row beneath the majority state for that particular character and taxon. * = Australian species.

	10 20 30 40 50 60 70 80 90 100
Photuris sp.	[illegible]
Atyphella aphrogeneia	[illegible]
Atyphella atra *	[illegible]
Atyphella brevis *	[illegible]
Atyphella carolinae	[illegible]
Atyphella conspicua *	[illegible]
[illegible]	[illegible]
Atyphella ellioti *	1011000400 0000000130 2?000?0200 [illegible]
Atyphella flammans *	[illegible]
Atyphella fraudulens *	[illegible]
Atyphella immaculata *	[illegible]
Atyphella inconspicua *	[illegible]
[illegible]	[illegible]
Atyphella lewisi *	[illegible]
Atyphella lychnus *	[illegible]
[illegible]	[illegible]
Atyphella majuscula *	[illegible]
Atyphella monteithi *	[illegible]
Atyphella olivieri *	[illegible]
Atyphella scintillans *	[illegible]
Atyphella similis *	[illegible]
Atyphella wolfi	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Bourgeoisia hypocrita	[illegible]
Colophotia praeusta	[illegible]
Curtos costipennis	[illegible]
[illegible]	[illegible]
Luciola (Luciola) australis *	[illegible]
Luciola (Luciola) cowleyi *	[illegible]
[illegible] *dejeani* *	[illegible]
[illegible] *flavicollis* *	[illegible]
[illegible]	[illegible]
[illegible] *nigra* *	[illegible]
Luciola (Luciola) orapallida *	[illegible]
Luciola (Hotaria) parvula	[illegible]
[illegible]	[illegible]
Pyrophanes beccarii *	[illegible]
Pteroptyx cribellata *	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
Pteroptyx platygaster *	[illegible]
Sinua	[illegible]
Hemiaxia	[illegible]

by placement in a separate row in Table 1, beneath the majority state for that particular character and taxon. PAUP (Swofford 1993), unlike Hennig86 (Farris 1988), can accept this polymorphic character scoring.

Character distributions are discussed in terms of the cladogram from the cladistic analysis (Fig. 35). Clades referred to are species-groups identified in the cladistic analysis and defined in Fig. 30.

RESULTS. Cladistic analyses of the entire data matrix of 44 taxa and 104 characters of equal weight, with *Photuris* sp. designated as the outgroup, could not be completed because of the tree-save limitation in PAUP. Several random-addition heuristic searches would finish but the tree-save limitation would be reached before all 10 searches completed. Repeated attempts to analyse the data matrix showed that trees of length 336 were present. Use of the nchuck command (Swofford 1993) to save only 30,000 trees of length less than, or equal to, 336 before moving to the next replicate retrieved 10,866 most parsimonious trees of tree length 336, consistency index (Kluge & Farris 1969) 0.53, consistency index excluding uninformative characters 0.48, retention index (Farris 1989) 0.70, and rescaled consistency index 0.40. We were not confident that all most parsimonious trees of length 336 had been found, nor that these were the most parsimonious trees. Strict and semistrict consensus of the trees of length 336 were identical and well resolved, and indicated the presence of three clades within the Luciolinae (Fig. 30).

The large number of most parsimonious trees is generated because of missing data (see introduction above). The data matrix assembled for this study included a considerable amount of missing data for certain taxa. We excluded nine species from further analyses, because both female and larvae are unknown. Analysis of the 104 characters for the 35 taxa, with 100 random

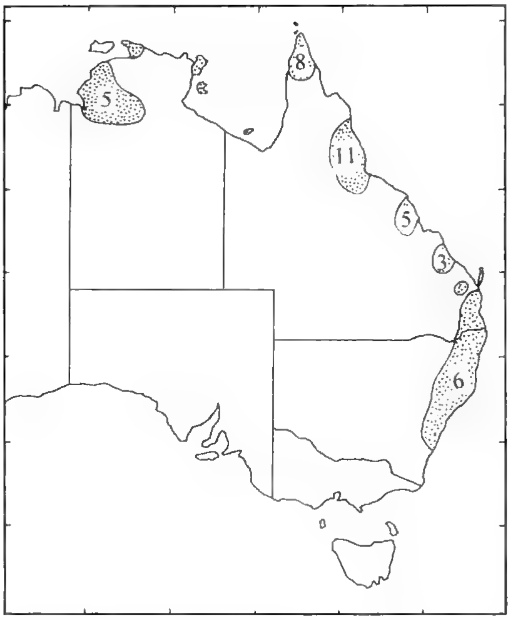


FIG. 28. Distribution of fireflies in Australia (figures show number of species in each zone).

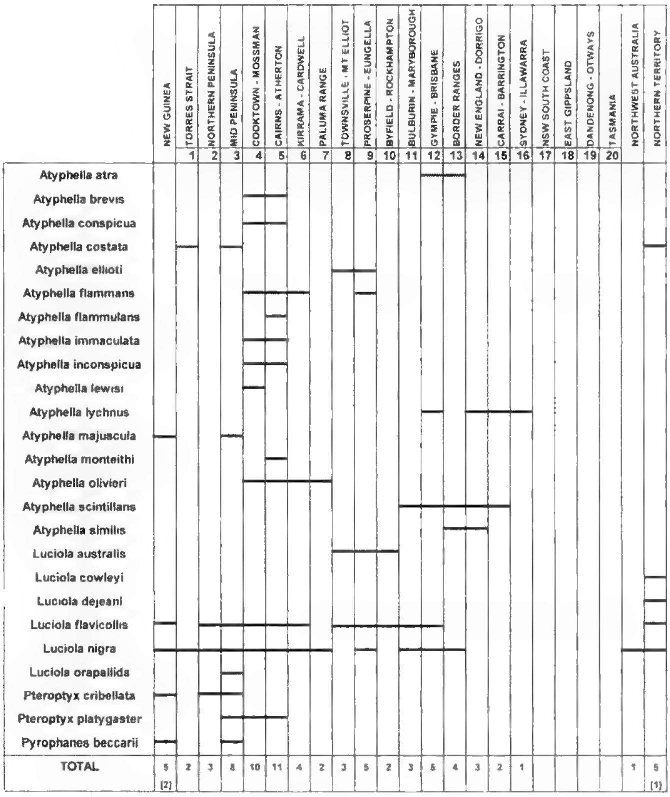
additions, generated 138 most parsimonious trees of tree length 301, consistency index 0.56, consistency index excluding uninformative characters 0.51, retention index 0.71, and rescaled consistency index 0.40. The semistrict consensus (Fig. 31A) shows the same three clades as found in the analysis of all 44 taxa. Successive weighting recovered 15 trees, however the strict (Fig. 31B) and semistrict consensus of these 15 successively weighted trees show a quite different arrangement of the ingroup, with the small medial *Curtos* clade, of Mt Missim and *Curtos costipennis*, dividing and moving basally.

Removal of taxa with considerable amounts of missing data is not advisable because information supporting relationships may be removed (Novacek, 1992) and instead safe taxonomic reduction (Wilkinson, 1995, 1997) was considered. However no taxonomic equivalents could be identified. *Atyphella brevis* and *A. lewisi*, and *A. flammulans* sp. nov. and *A. flammans* differ by a single homoplasious, but informative character, 23. *Atyphella brevis* and *A. flammulans* sp. nov. only, were excluded from the next analysis, as this should have less effect on inferred relationships than the removal of nine taxa. Analysis of the 104 characters for the 42 taxa, with 10 random additions, generated 5,586 most parsimonious trees of tree length 334, consistency index 0.54, consistency index excluding uninformative characters 0.48, retention index 0.70 and rescaled consistency index 0.38. The identical strict and semistrict consensus (Fig. 32A) show the same three clades found in the analysis of all 44 taxa, but with slightly different arrangements in the *Atyphella* clade. Successive weighting recovered 294 trees. The identical strict (Fig. 32B) and semistrict consensus of these 294 successively weighted trees also shows the same three clades.

We were concerned that the presence of polymorphisms may have contributed to the large number of most parsimonious trees generated. An analysis was made of the entire 44 taxa with polymorphisms removed. The majority state was maintained in taxa that had been coded as polymorphic, and the minority state (shown in the rows below the majority state in Table 1) removed. This analysis generated 20,411 most parsimonious trees of tree length 317, consistency index 0.50, consistency index excluding uninformative characters 0.44, retention index 0.70 and rescaled consistency index 0.35. The strict and semistrict consensus (Fig. 33A) show the same three clades as found in the analysis of all 44 taxa with polymorphisms included. Successive weighting of the most parsimonious trees recovered the 78 trees, and the strict and semistrict consensus (Fig. 33B), of these 78 successively weighted trees shows the same three clades as in the unweighted analysis.

As near taxonomic equivalents, *Atyphella brevis* and *A. flammulans* sp. nov. were excluded from an analysis of the data matrix without polymorphisms. Analysis of the 104 characters, with polymorphisms removed, for the 42 taxa, with 10 random additions, generated 1,029 most parsimonious trees of tree length 315, consistency index 0.50, consistency index excluding uninformative characters 0.44, retention index 0.70 and rescaled consistency index 0.35. The identical strict (Fig. 34A) and semistrict consensus show the same three clades as found in the analysis of all 44 taxa without polymorphisms. Successive weighting recovered 78 trees. The strict and semistrict consensus (Fig. 34B) of these 78 successively weighted trees also show the same three clades.

As Hennig86 is unable to process polymorphic scorings, the most parsimonious tree to show characters and character states was selected from the analysis of the entire data matrix without



	NEW GUINEA	TORRES STRAIT 1	NORTHERN PENINSULA 2	MID PENINSULA 3	COOKTOWN - MOSSMAN 4	CAIRNS - ATHERTON 5	KIRRAMA - CARDWELL 6	PALUMA RANGE 7	TOWNSVILLE - MT ELLIOT 8	PROSERPINE - EUNGELLA 9	BYFIELD - ROCKHAMPTON 10	BULBURIN - MARYBOROUGH 11	GYMPIE - BRISBANE 12	BORDER RANGES 13	NEW ENGLAND - DORRIGO 14	CARRAI - BARRINGTON 15	SYDNEY - ILLAWARRA 16	NSW SOUTH COAST 17	EAST GIPPSLAND 18	DANDENONG - OTWAYS 19	TASMANIA 20	NORTHWEST AUSTRALIA	NORTHERN TERRITORY
Atyphella atra													—	—									
Atyphella brevis					—	—																	
Atyphella conspicua					—	—																	
Atyphella costata		—		—																			—
Atyphella ellioti									—	—													
Atyphella flammans					—	—	—			—													
Atyphella flammulans						—																	
Atyphella immaculata					—	—																	
Atyphella inconspicua					—	—																	
Atyphella lewisi					—																		
Atyphella lychnus													—		—	—	—						
Atyphella majuscula	—			—																			
Atyphella monteithi						—																	
Atyphella olivieri					—	—	—	—															
Atyphella scintillans												—	—	—	—	—							
Atyphella similis														—	—								
Luciola australis									—	—	—												
Luciola cowleyi																							—
Luciola dejeani																							—
Luciola flavicollis	—		—	—	—	—	—		—	—	—	—	—										—
Luciola nigra	—	—	—	—	—	—	—	—		—		—	—	—								—	—
Luciola orapallida				—																			
Pteroptyx cribellata	—		—	—																			
Pteroptyx platygaster				—	—	—																	
Pyrophanes beccarii	—			—																			
TOTAL	5 [2]	2	3	8	10	11	4	2	3	5	2	3	6	4	3	2	1					1	5 [1]

FIG. 29. Table summarising distribution of the Australian Lampyridae in alphabetical and taxonomic sequence. Presence of each species in the north-south sequence of geographic zones is indicated by the solid horizontal bar.

polymorphisms and with the two near taxonomic equivalent taxa removed. Strict and semistrict consensus of both weighted and unweighted analyses were used as a guide to choose the preferred most parsimonious tree (Fig. 35).

DISCUSSION

SAFE TAXONOMIC REDUCTION. With taxa containing considerable proportions of missing characters (over 70%), and missing some characters in all 25 taxa, Wilkinson (1997) using parsimony analysis with PAUP version 3.1.1 (Swofford, 1993) generated over 30,000 most parsimonious trees. The removal of three taxonomically equivalent taxa, while still retaining taxa with over 65% missing data generated 456 most parsimonious trees. Wilkinson (1995) considered that taxonomic equivalent taxa could be removed from the analysis without affecting inferred relationships, tree lengths, or consistency indices. However it is obvious that removal of taxonomic equivalents from the matrix may result in changes in tree length and consistency indices if the taxa removed contain autapomorphs.

The removal of the nine taxa that contained the largest proportion of missing data significantly decreased the number of most parsimonious trees generated during analysis. While resolution increased in parts of the *Luciola/Pteroptyx* clade in the consensus tree, resolution was lost in the *Atyphella* clade. Removal of only two near taxonomic equivalents also decreased the number of most parsimonious trees generated, but not as significantly, and resolved some sections of the *Atyphella* clade.

The presence of polymorphic taxa also increased the number of most parsimonious trees. Recoding of these taxa for majority states allowed a slight increase in the resolution of the consensus trees. A slight improvement in resolution was also observed in the consensus trees for the analysis with polymorphisms and two near taxonomic equivalents removed.

Successive weighting, by decreasing the weight of the homoplasious characters, can lead to changes in topology and resolution. The only significant changes to topology that can be attributed to successive weighting occurred after removal of nine taxa from the data matrix. The support for the *Curtos* clade is based on homoplasious characters. Downweighting of those characters, together with the removal of one of the three taxa, removed the support for the grouping and allowed the remaining two taxa to split and move. Increased resolution in the consensus trees was observed in all successively weighted analyses. Except for the analysis with nine taxa removed, the successively weighted continue to show the same three, well resolved, monophyletic clades.

The effect of successive weighting on polymorphic and multistate characters has not been

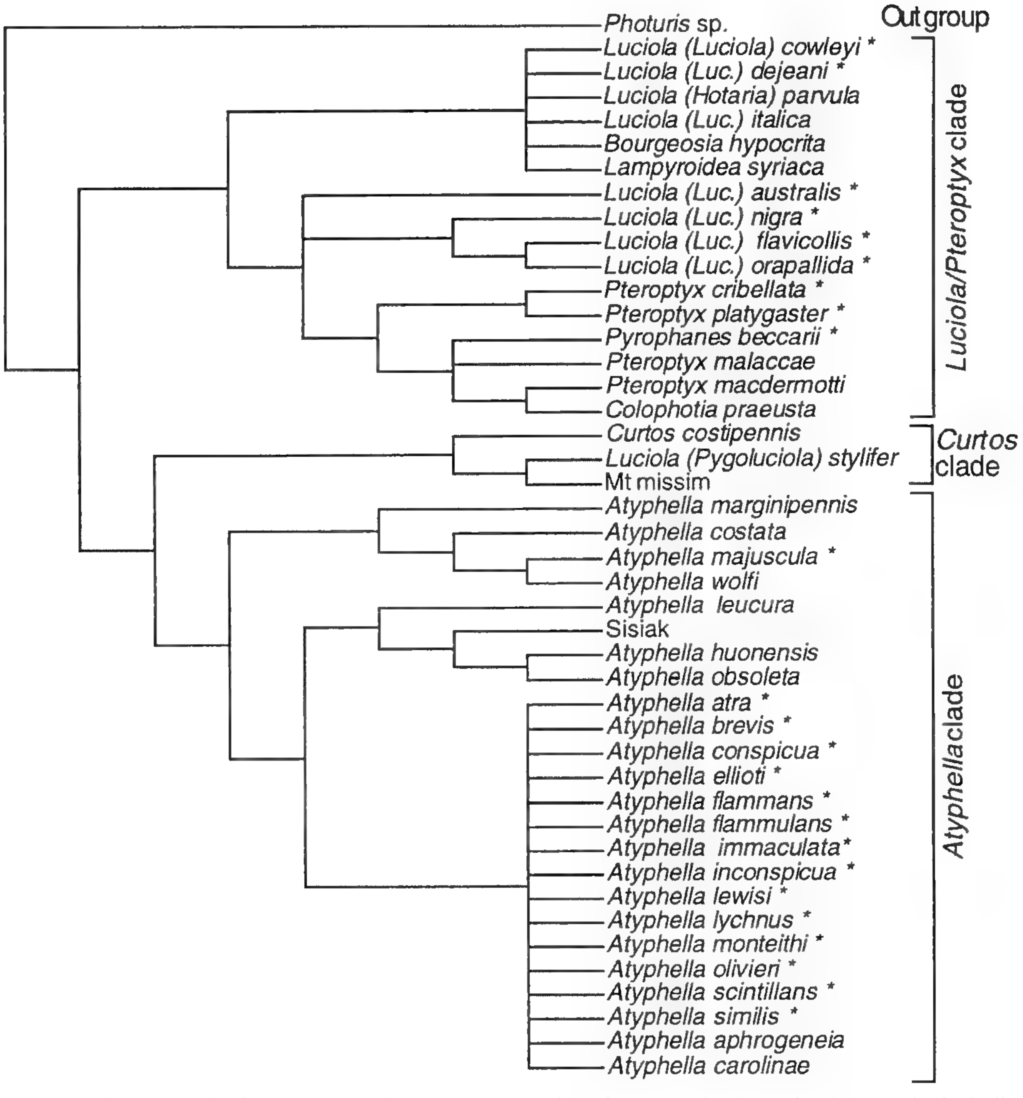


FIG. 30. Strict and semistrict consensus of 10,866 most parsimonious trees for the entire data matrix, including polymorphisms, of 44 taxa.

investigated. Successive weighting downweights the homoplasious characters. If homoplasy is confined to a single state in a multistate character or one of the morphs in a polymorphic character, the rescaled consistency index, upon which the successive weighting is based, falls and the entire character is downweighted. The data matrix for this phylogenetic study of the Luciolinae contains 34 multistate characters, and seven coded as polymorphic across 14 taxa. A direct comparison can be made on the consensus trees for the analyses with two near taxonomic equivalents between the consensus trees for the analysis with polymorphisms (Fig. 32) and the consensus trees for the analysis with polymorphisms removed (Fig. 34). Removal of polymorphisms allowed *B. hypocrita* and *L. cowleyi* to form a clade and the position of *Py. beccarii* to be clarified. Successive weighting without polymorphisms shows greater resolution of the relationships in the *Atyphella* than the successive weighting of the data matrix including

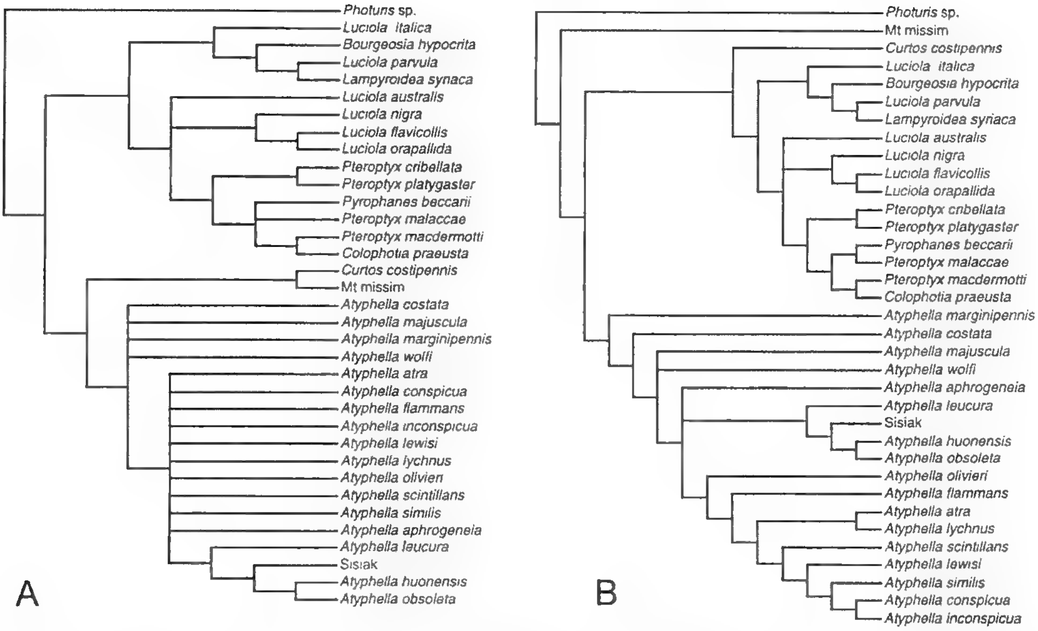


FIG. 31. Effect of removing nine taxa missing all female and larval characters. A, semistrict consensus of 138 most parsimonious trees for the data matrix, including polymorphisms, of 35 taxa. B, strict and semistrict consensus of the 15 successively weighted trees from the 138 most parsimonious trees for the data matrix, including polymorphisms, of 35 taxa.

polymorphisms. The presence of polymorphic taxa does not only significantly increase the number of most parsimonious trees, but also decreases the resolution of consensus trees from both equally weighted and successively weighted analyses.

THE LUCIOLINAE. Three monophyletic clades (Fig. 30) are recognised in the Luciolinae. Basally the *Luciola/Pteroptyx* clade includes *Luciola (Luciola) australis, L. (L.) cowleyi, L.(L.) dejeani, L. (L.) flavicollis, L. (L.) italica, L. (L.) nigra, L. (L.) orapallida, Luciola (Hotaria) parvula, Pteroptyx cribellata, Pter. macdermotti, Pter. malaccae, Pter. platygaster, Bourgeosia hypocrita, Lampyroidea syriaca, Colophotia praeusta*, and *Pyrophanes beccarii*. Medially the *Curtos* clade is comprised of Mt Missim, *Curtos costipennis* and *L. (Pygoluciola) stylifer*. The terminal *Atyphella* clade includes *Atyphella aphrogeneia, A. atra, A. brevis, A. carolinae, A. conspicua, A. costata, A. ellioti* sp. nov., *A. flammans A. flammulans* sp. nov., *A. immaculata, A. inconspicua, A. leucura, A. lewisi, A. lychnus, A. majuscula, A. marginipennis, A. monteithi, A. olivieri, A. scintillans, A. similis, A. wolfi, A. huonensis, A. obsoleta* and Sisiak.

The same three clades are found in all analyses except the successively weighted analysis with the removal of the nine taxa missing all female and larval characters. In this successively weighted analysis the medial clade changes position and splits, Mt Missim becoming basal to the Luciolinae and *Curtos costipennis* joining the *Luciola/Pteroptyx* clade basally (Fig. 31B). *Luciola (Pygoluciola) stylifer* and Mt Missim form a well supported group in all analyses that include both species. The inclusion of *Curtos costipennis* in the clade is poorly supported, as is the clade itself (Figs 34A, B). As the clade is grouped by three homoplasious characters, of which two involve elytral colour patterns, low Bremer supports result.

The *Luciola/Pteroptyx* clade contains two well-supported clades in all analyses: viz. *Lampyroidea syriaca, Bourgeoisea hypocrita, Luciola italica, L. (L.) dejeani, L.(L.) cowleyi*; and *Luciola (Hotaria) parvula*, and *Luciola (Luciola) australis, L. (L.) flavicollis, L. (L.) nigra, L. (L.) orapallida, Pteroptyx cribellata, Pter. macdermotti, Pter. malaccae, Pter. platygaster, Colophotia praeusta*, and *Pyrophanes beccarii*. These clades present confused subgeneric,

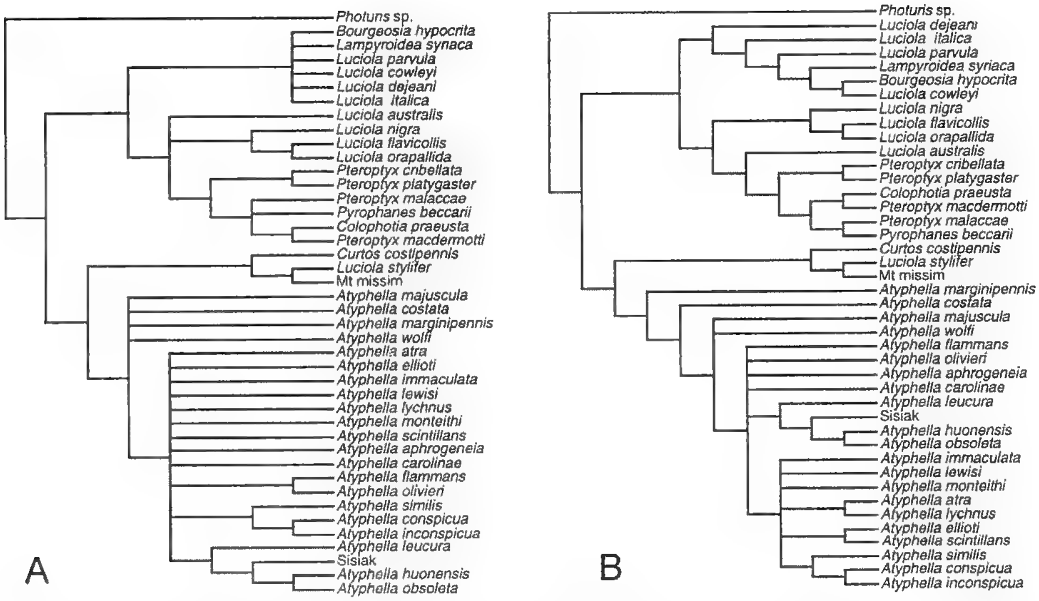


FIG. 32. Effect of removing two taxa, missing many values, that differ from other taxa in one homoplasious character. A, strict and semistrict consensus of 5,586 most parsimonious trees for the data matrix including polymorphisms, of 42 taxa. B, strict and semistrict consensus of the 294 successively weighted trees from 5,586 most parsimonious trees for the data matrix including polymorphisms, of 42 taxa.

generic and family relationships, which may be resolved by the future inclusion of further species in each category.

This analysis supports the generic status of *Atyphella*. McDermott's transfer of *Atyphella* species to *Luciola* subgenus *Luciola* in 1966 is not vindicated. *Atyphella* is now considered to include the following 23 species (six originally described as *Luciola* species): Australian species; *atra* Lea, *brevis* Lea, *conspicua* sp. nov., *costata* (Lea), *ellioti* sp. nov., *flammans* Olliff, *flammmulans* sp. nov., *immaculata* sp. nov., *inconspicua* (Lea), *lewisi* sp. nov., *lychnus* Olliff, *majuscula* (Lea), *monteithi* sp. nov., *olivieri* lea, *scintillans* Olliff, *similis* sp. nov.: non-Australian species; *aphrogeneia* (Ballantyne), *carolinae* Olivier, *huonensis* (Ballantyne), *leucura* Olivier, *marginipennis* (Guérin), *obsoleta* Olivier, *wolfi* (Olivier). While the *Atyphella* clade is supported by three homoplasious characters, none involving colour, the posterior asymmetry of the aedeagal sheath sternite is a clear synapomorphy for the group.

Ballantyne (1968) erected *Pygatyphella*, as a subgenus of *Luciola*; distinguished by its distinctive abdominal modifications, but named for its similarities to *Atyphella*. This study shows a close relationship between two species of *Luciola* (*Pygatyphella*) (viz. *obsoleta* Olivier and *huonensis* Ballantyne) and *Atyphella*, and all species of this subgenus should be investigated. However based on these results a well-supported species-group within *Atyphella* contains *obsoleta*, *huonensis*, *leucura* and the undescribed Sisiak.

DISTRIBUTION. Distributional patterns for Australian fireflies are presented as a map of locality records for the whole of Australia (Fig. 28), maps of locality records for individual species in each genus (Figs 8-11, 13-14, 16-18, 23-25, 27) and tabulation of the extent of species through defined regions along the eastern seaboard of Australia (Fig. 29). The rainforests of far north Queensland have been well collected and the data reveal what must be a very fair picture of firefly distribution in those areas. Other areas are less clear.

McDermott & Buck (1959) remarked on the paucity of Australian Lampyridae, contrasting the Jamaican fauna where there are about 50 distinct species. They considered *Luciola* species were probably recent immigrants from New Guinea, and that Australia was isolated since the late Cretaceous probably before the lampyrids

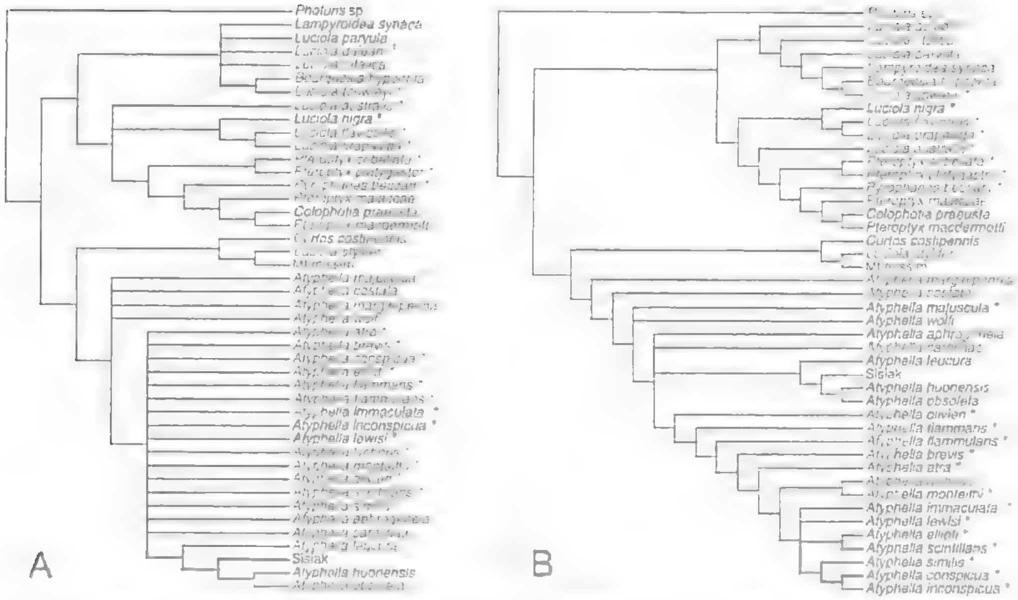


FIG. 33. Effect of polymorphisms. A, strict and semistrict consensus of 20,441 most parsimonious trees for the entire data matrix with polymorphisms removed, of 44 taxa. B, semistrict consensus of the 78 successively weighted trees from the 20,441 most parsimonious trees for the data matrix with polymorphisms removed, of 44 taxa.

had spread sufficiently to be represented in the endemic fauna.

So little is known of much of the *Luciola* of the Oriental Region that a discussion of distribution and possible origins of Australian representatives is inappropriate here. Other groups are better known. While *Atyphella* occurs outside Australia in New Guinea and the western Pacific, almost all of the *Atyphella* treated here are Australian endemic. *Pteroptyx* and *Pyrophanes* occur in New Guinea, Indonesia and Malaysia, and only *Pteroptyx platygaster* is restricted to Australia (Ballantyne & McLean, 1970; Ballantyne, 1968, 1987a, 1992).

This discussion of distribution will concentrate on the eastern coast of Australia where fireflies occur from islands of the Torres Strait south to Kiama in NSW, with their distribution largely paralleling the distribution of rainforest and/or mangroves. Monteith (1997) overviewed the distribution of rainforests and possible natural barriers along the east coast and this treatment owes much to that overview.

Only 2 species are known from mangroves, *Luciola orapallida* in Cape York Pen. and *L. australis*, which occurs from Townsville to Bundaberg. Both have slim bodied active larvae which may be able to move more easily through the mud and slime of this habitat.

The far north tropical area has the most diverse fauna. The narrow coastal strip east of Coen in Cape York Pen. and the Iron Range area support the most species from any part of Australia. This is the rainforest system which Darlington (1961) named the 'mid-Peninsula' region. Monteith (1997) showed it also has the richest local fauna of Aradidae in Australia. Six species, *Pyrophanes beccarii*, *Pteroptyx cribellata*, *Atyphella majuscula*, *Luciola nigra*, *L. flavicollis* and *L. orapallida* occur here. Five also occur outside Australia, and of these, three, viz. *Pyrophanes beccarii*, *Pteroptyx cribellata* and *A. majuscula*, may be recent immigrants from New Guinea, as they are not known farther south. *Luciola orapallida* occurs in mangrove and salt-water couch, where it may replace *L. australis*, which occurs in a similar habitat further south. *Pteroptyx*, which is widely distributed in New Guinea (Ballantyne, 1987a) occurs as far south as Innisfail. Only *L. nigra* and possibly *L. flavicollis* have a much wider distribution along the eastern Australian coast as far south as the southeast corner of Queensland. All of these six 'mid-Peninsula' species have winged females.

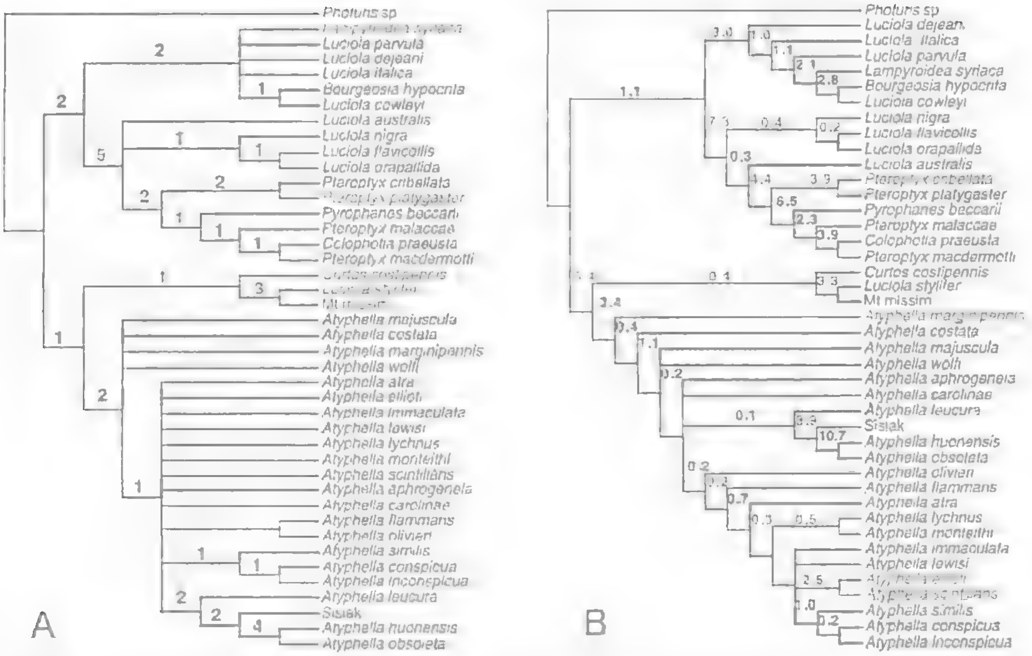


FIG. 34. Effect of polymorphisms and removing only two taxa, missing many values, that only differ from other taxa in one homoplasious character. A, strict and semistrict consensus of 1,029 most parsimonious trees for the data matrix with polymorphisms removed, of 42 taxa. Two species were excluded that only differ from other taxa in one homoplasious character. Bremer support values indicated calculated on the first saved most parsimonious tree. B, strict and semistrict consensus of the 78 successively weighted trees from 1,029 most parsimonious trees for the data matrix including with polymorphisms removed, of 42 taxa. Bremer support values indicated calculated on the first saved successively weighted tree.

South of the central peninsula two different patterns emerge, that of *Atyphella* in association with rainforest tracts, and of certain *Luciola* which appear to be widely distributed in more open forest and not restricted by rainforest tracts.

Atyphella species may have entered Australia several times. A recent influx of *A. majuscula* is restricted to the far north in Cape York Pen. An older element became widely distributed along the east coast before the rainforest corridor became so restricted. In eastern Australia there are now 2 distinct groups of this older element separated by a dry Mackay to Bulburin barrier. The wet tropical group (north of Cooktown to Eungella) has 9 *Atyphella* species, all endemic to this area. They occur mainly in rainforest and five species (all with flightless females with advanced wing loss) are known from above 400 metres (Figs 8-11, 13, 16). Two species are coastal (*flammans* is widespread while *monteithi* is known only from the Cairns area). *flammulans* is known from coastal and higher regions, and *olivieri* has a wide distribution through the wet tropics as far south as Paluma and occurs from sea level to above 1,000 metres. Of these *flammans* and *olivieri* have females in which the hind wings are abbreviated.

In the block south of Rockhampton 4 species occur (Figs 14, 17, 18): they are associated with cooler temperate rainforest of the type which was widespread and shared by other southern continents before the break-up of Gondwanaland. Of these the *A. lychnus* female may have acquired its flightlessness fairly recently and it has a wide and discontinuous distribution in SE Qld and NE and central NSW. However *A. similis* and *A. scintillans*, which have brachelytral females, have a wide distribution. Only *A. atra* is relatively confined.

Species of *Luciola* fall into three distributional groups. Most are not apparently restricted by rainforest boundaries and where known the female is winged and capable of flight.

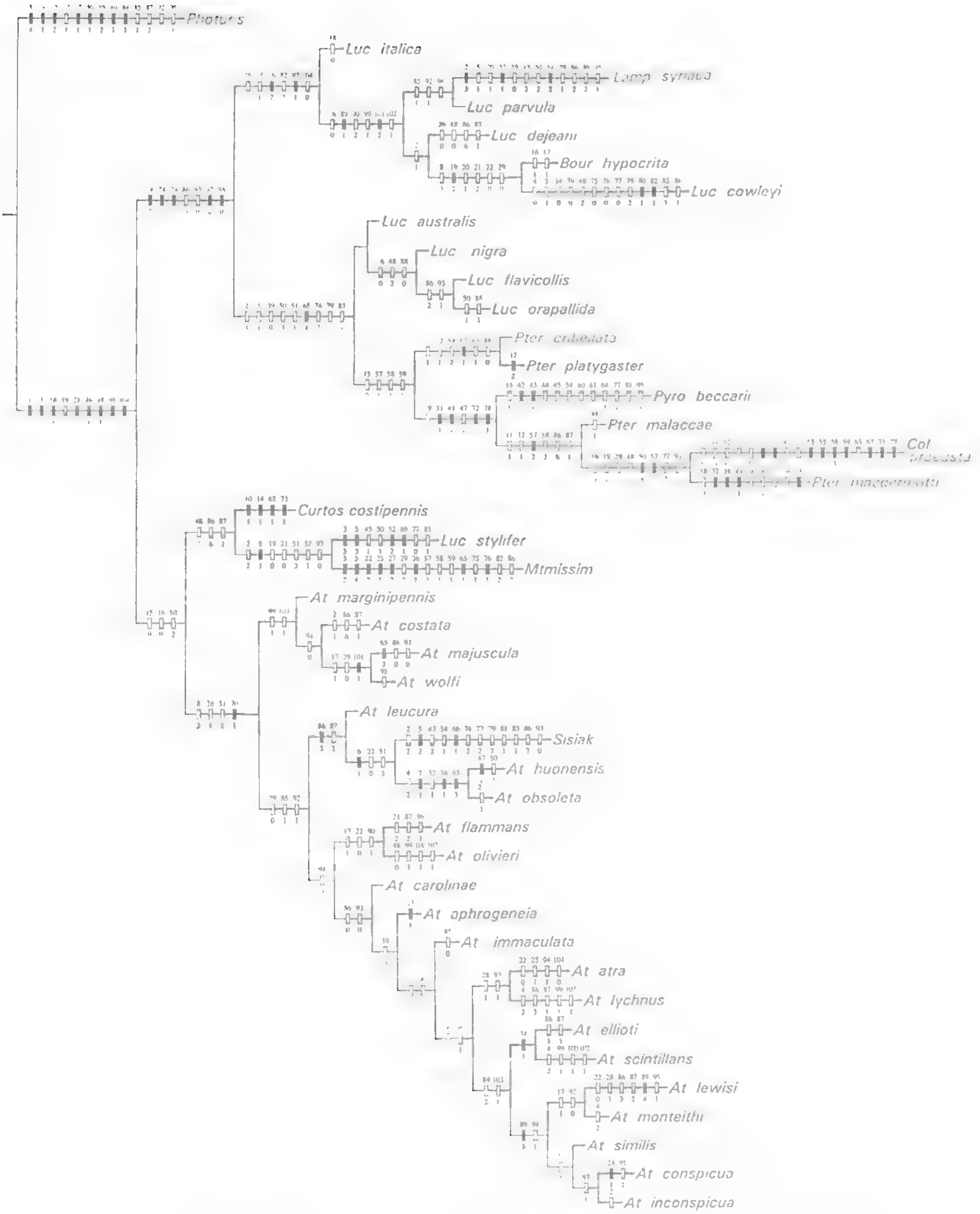


FIG. 35. Preferred most parsimonious tree for the entire data matrix with polymorphisms removed, of 42 taxa, showing characters and character states. White blocks, reversal without homoplasy; black, forward change without homoplasy; stippled, homoplasy.

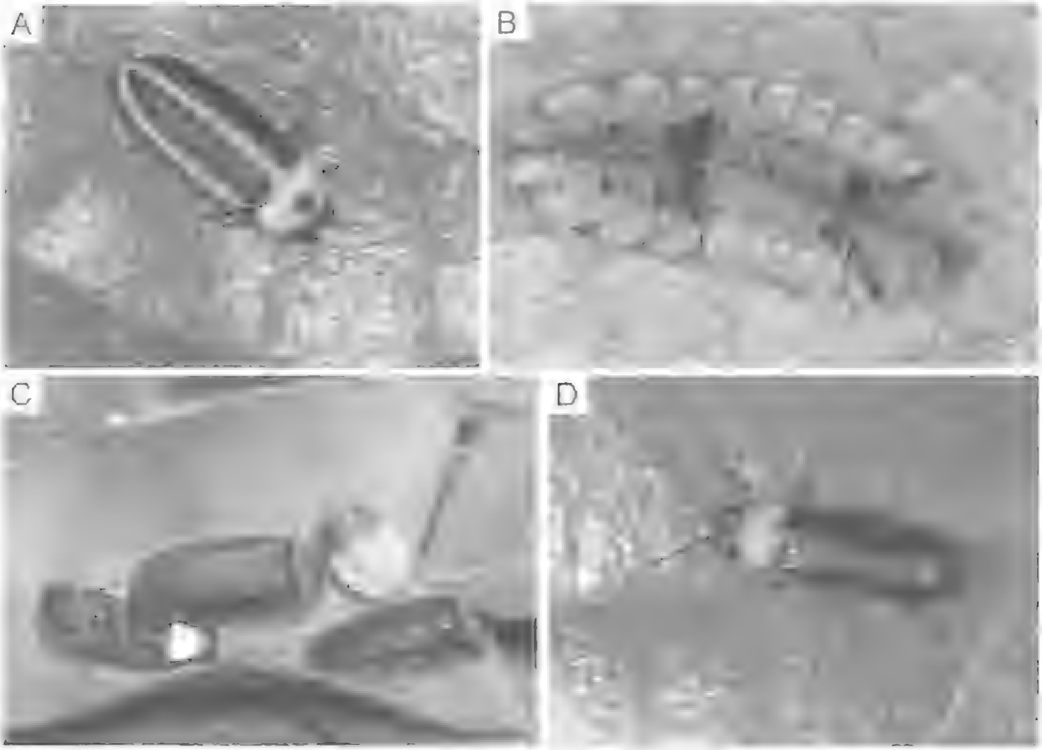


FIG. 36. Living Australian fireflies. A, *Atyphella olivieri*, adult ♂; B, *Atyphella flammans*, larva; C, *Atyphella* scintillans, three macropterous ♂♂ and one brachypterous ♀; D, *Luciola nigra*, adult ♂. (Photos A, B, D, Jeff Wright, QM; C, Bruce Cowell, QM)

L. dejeani may not be Australian. Its distinctive dorsal colouration is shared with *A. costata* and at least 40 other *Luciola* species in Asia and Indomalaysia (McDermott, 1966).

L. cowleyi (Fig. 23) is reliably known only from the Northern Territory where it seems to occur along rivers. The female is unknown.

The third group includes *L. nigra* and *L. flavicollis* (Figs 23-25) which occur across the north of Australia and extend into southeast Qld. They appear to be restricted only by tropical and warm temperate climates and not by rainforest distribution as for *Atyphella*. Both occur in New Guinea (Ballantyne, 1992). Males fly readily, and females can fly. While *L. nigra* has been collected from rainforest and relict rainforest, *flavicollis* is known only from more open sclerophyll forest (LB observations). *L. nigra* flies with *A. scintillans* in the Brisbane area, and at Burleigh Heads NP in an area of rainforest, but it may have flown into the latter area rather than being restricted to it. *L. flavicollis* is very widely distributed across northern Australia, from Cape York to SE Qld and west at least to Carnarvon, and is often attracted to light (LB observations) although LB has never observed it flying in numbers exceeding five.

FEMALE APTERY. McDermott & Buck (1959: 14) considered apterous females likely to develop in high wind areas, wing degeneracy a specific character rather than being common to groups of species, and that the first step is an alate female that seldom flies. Some observations of known behaviour in Australasian fireflies both support and contradict their position.

A. aphrogeneia, the 'surf firefly', has a winged and flighted female living in a precarious position in the surf spray zone (Ballantyne & Buck, 1979; Lloyd, 1973a). Australian observations (Powell, 1964; Ballantyne, 1992) indicate that females rarely fly once a mate has been selected. *Luciola australis* females crawl up low vegetation with head uppermost and may even flex the abdomen so that the light shines upwards. Flashes of females on the ground or low vegetation may be reflected from leaf surfaces or transmitted through the pale abdomen and are easily seen from above. No *Luciola* female from the Australian and Indomalaysian area is flightless. Flightless *Atyphella* females behave similarly (LB's observations on interactions in Lamington and Mt Glorious NP).

In Australia wingless females occur only in *Atyphella*. In the northern tropics where barriers to distribution may be altitude as well as discontinuity of rainforest (Monteith, 1997) those species with the most restricted distribution have brachelytral females (females are not associated for all species however). Species with females where the wing loss is restricted to a shortening of the hind wings (e.g. *olivieri*, *flammans*) have a wider, often somewhat discontinuous distribution which may reflect a more recent loss of flight ability. On the other hand, where the rainforest is not separated by such major barriers in SE Qld and NE NSW, three species of *Atyphella* (all with flightless females) are widely distributed.

COLOUR PATTERNS. Dorsal colour patterns may be a response to external factors. The conspicuous orange pronotum and brown or black elytra common in New Guinea occurs in *Pteroptyx*, *Pyrophanes*, four *Luciola* (two from tropical mangrove areas, two from open forest in tropical and warm temperate areas) and two tropical *Atyphella* and is interpreted as warning colouration (Ballantyne, 1968, 1992). Only two species have a yellow body with dark elytral apices, seen widely in Indomalaysia (McDermott, 1966).

Atyphella spp. from rainforest have colour patterns which will disrupt or confuse their outlines e.g. dark pronotal markings, striped or pale margined elytra. The human eye does not easily detect these insects in the daytime (LB observations).

MORPHOLOGY AND BEHAVIOUR. Ballantyne (1987b) discussed many lucioline morphological modifications and made behavioural inferences. The *Atyphella* male pronotum conceals the head from above and, as eyes occupy much of the ventral head area, vision is directed down in flight. Males actively searching on the ground protrude their heads (Ballantyne, 1992). The more exposed head of *Pteroptyx*, *Pyrophanes* and *Luciola* may allow extra head mobility, and greater visual acuity thus predisposing them to aerial interactions.

Leg modifications occur only in *Pyrophanes* males, which have a metafemoral comb. Lloyd (1979a) surmised its function (in *Pteroptyx*) to kick aside the female elytra before copulation.

Deflexed elytral apices in *Pteroptyx* correlate with abdominal modifications in *P. valida* where the female abdomen is clamped between the elytral apices and the MPP of sternite 7 (the 'copulation clamp' of Lloyd et al. (1989), Wing et al. (1983) and Ballantyne (1987a). The wider occurrence of such behaviour among other species with deflexed elytral apices is not known.

Abdominal modifications may reflect the necessity for muscle attachment related to complex mating protocols involving abdominal flexion (Ballantyne, 1987b, 1992). A bipartite or abbreviated light organ in sternite 8 provides surface area for longitudinal muscle attachment (muscles are visible through the semitransparent cuticle). Such potential flexibility in *Pteroptyx* species is demonstrated by the forward arching of the posterior margin of ventrite 4 (Ballantyne, 1987a: fig. 3a; Ballantyne, 1992) providing a base for muscle attachment. By contrast, Australian *Atyphella* with entire light organs in sternite 7, no forward arching of basal ventrites and no apparent modifications to tergite 8 are assumed to have simpler mating interactions (Ballantyne, 1987b). All *Atyphella* have pale terminal tergite(s) through which the light can be seen clearly. Both species of *Pteroptyx* and two *Luciola* species have very dark terminal tergites so the main light source will only be seen from below unless the abdomen is flexed.

Eberhard (1985) indicated the correlations that exist between genitalic diversity, or lack of it, and sexual characters developed on the terminal abdomen and elsewhere. Many lucioline males belong to his category where secondary body parts (e.g. elytral apices) are used to copulate and morphological variation in these is wide, whereas the primary genitalic structures do not diverge. Similarities between the aedeagal structure of the two Australian species of *Pteroptyx* and certain *Luciola* (*nigra*, *flavicollis*) are offset by species-specific differences in abdominal sternite 7, as well as by the deflexed elytral apex in *Pteroptyx*.

Pyrophanes males exhibit features of the male terminal abdomen and leg modifications, which may be secondary sexual characters (Ballantyne, 1987b). The aedeagus appears to be fairly uniform (Ballantyne, 1992).

The uniform aedeagus structure among most *Atyphella* is not related to secondary sexual characters as the terminal abdomen exhibits uniformity of structure. Few records herein show more than two *Atyphella* species sympatric in time and space.

ASSOCIATION OF FEMALES AND LARVAE. Distribution has been used to associate some larvae and females with males. Most adults are collected while flashing. Unless a flightless female is accidentally taken in leaf litter she will only be collected because her light is seen. She can be associated with males flying at the same time and place (if there is only one species present). No such inference can be made for larvae, which are unpredictable in their light production. In few cases have larvae been reliably associated by rearing.

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CUEMUS, A NEW GENUS OF TENEBRIONIDAE (COLEOPTERA) FROM THE NORTHERN QUEENSLAND WET TROPICS

P. BOUCHARD

Bouchard, P. 2000 12 31: *Cuemus*, a new genus of Tenebrionidae (Coleoptera) from the northern Queensland Wet Tropics. *Memoirs of the Queensland Museum* **46**(1): 95-100. Brisbane. ISSN 0079-8835.

A new genus, *Cuemus*, is described from mountain rainforests in the northern Queensland Wet Tropics and placed in the tribe Coelometopini (Coleoptera: Tenebrionidae: Coelometopinae). Two allopatric new species, *C. monteithi* and *C. cooki*, are described, illustrated and keyed. *Cuemus* belongs to a monophyletic group that includes *Asopidiopsis* Kaszab and *Micromenandris* Kaszab, both endemic to Fiji. ❐ *Coleoptera, Tenebrionidae, Coelometopinae, Cuemus, Australia, rainforest.*

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Until about 25 years ago, the higher classification of the large beetle family Tenebrionidae (>15,000 species; Watt, 1982) had remained practically unchanged since Lacordaire's initial treatment of the world fauna (Lacordaire, 1859). Examination of larvae and internal organ systems has recently yielded a number of phylogenetically useful characters which have helped to redefine relationships within the family (Watt, 1974; Doyen & Lawrence, 1979; Tschinkel & Doyen, 1980; Doyen & Tschinkel, 1982). Based on this new evidence, the subfamily Coelometopinae, which includes the tribes Coelometopini, Strongyliini and Talanini (see Doyen, 1989), is thought to be the best supported clade within the family (Doyen & Tschinkel, 1982).

The diverse tribe Coelometopini is characterised by the presence of stellate sensoria on the last five to six antennal segments, reniform compound eyes separated by more than the width of one eye, paraproct baculi transverse (or rarely oblique as in *Zophophilus* Fairmaire), spermatheca derived from the apex of the accessory gland, as well as elongate defensive reservoirs usually with annular folds (Doyen, 1989). Coelometopini are especially species-rich in forested habitats in the tropical and subtropical regions of the world and the tribe contains a large number of flightless species as well as fully winged forms (Doyen, 1989). The adults are known to browse on fungal and algal growths on the outer surface of dead and live trees at night (Monteith, 1995) and the larvae can be found both in, and under the bark of, dead and decaying wood (Marshall, 1982).

Approximately 100 described species in the tribe Coelometopini are known to occur in Australia. As for most of the Australian tenebrionids, the majority of these species were described during the late 1800's and early this century and only isolated and sporadic papers on this fauna have appeared since the 1930's (Doyen et al., 1990). Although adults are often scarce in collections (Doyen, 1995), the intensive sampling of northern Queensland's rainforest invertebrates by Queensland Museum staff, over the past decades, has yielded a large number of Coelometopini specimens (see Monteith, 1995). Approximately 50 undescribed species of Coelometopini are known to occur in these diverse rainforests. This paper describes a new genus (*Cuemus* gen. nov.) and two new species (*C. monteithi* sp. nov. and *C. cooki* sp. nov.) of Australian Coelometopini, discovered during this survey, and which are apparently restricted to high altitude rainforests in northern Queensland. Members of the genus are compact, convex beetles which superficially resemble species of the common Australian tenebrionid genus *Amarygmus* Dalman (Tenebrioninae: Amarygmini).

MATERIALS AND METHODS

All specimens of *Cuemus* were collected by QM staff and the author and are lodged in the following collections: QM, Queensland Museum, Brisbane (G. Monteith, C. Burwell); UQ, University of Queensland Insect Collection, Brisbane (G. Daniels); ANIC, Australian National Insect Collection, Canberra (J.F. Lawrence); SAM, South Australian Museum, Adelaide (E.G. Matthews). Measurements (in millimetres) were made using a graticule in a Zeiss Stemi SV6 stereomicroscope. The holotype measurement is given first with range of other specimens in parentheses. Illustrations were made using a drawing tube mounted on the same microscope. Dissection techniques and terminology of the anatomy of the defensive glands, ovipositor and female genital tube follow Tschinkel & Doyen (1980). The dissected genitalia are stored in glycerine in a genitalia vial mounted on the specimen pin. Terminology of the skeletal anatomy follows Lawrence & Britton (1994) and Lawrence et al. (1999). Specimens with the labels 'QMT(5 digit number)', refer to the Queensland Museum's register database. Data in square brackets in the specimen lists are not present on the insect labels but included for added clarity.

Cuemus gen. nov.

TYPE SPECIES. *Cuemus monteithi* sp. nov.

ETYMOLOGY. Derived from an acronym of the Queensland Museum 'QMus'.

DESCRIPTION. Body very convex in lateral view, nitid, small, widest near middle of elytra; colour ranging from light brown to reddish brown; legs and antennae long and thin.

Head. Perpendicular to ground surface at rest, hypognathous. Punctations on cranium rather deep, consisting of single punctures a little smaller than one ommatidium. Area between eyes flat, about 3 times width of one eye. Eyes small, reniform, incised anteriorly by frontal canthus. Frons rounded above antennal insertion. Frontoclypeal suture semicircular, deep. Clypeus transverse, slightly widened apicad, anterior border slightly convex in middle. Anterior corners of clypeus extending beyond frontoclypeal suture, bearing a number of longer, fine yellow setae. Clypeal membrane completely exposed, trapeziform (Fig. 2A). Apical border of labrum straight, whitish. Supraorbital crest absent. Area behind eyes constricting sharply, continuing ventrally to form an angular fold in postgenal region. Mentum convex, without median longitudinal ridge. Mandibles bifid. Marginal ridge of mandibles prominent. Apical segment of maxillary palp securiform. Apex of lacinia without digitus. Antennae long, cylindrical, slender, reaching middle of elytra (Figs 1C, 2B). Last 6 segments bearing stellate sensoria. All segments covered by fine yellow setae.

Prothorax. Globular, wider than long, widest near middle, with very narrow and shallow lateral margins; anterior and posterior margins incomplete; anterior border straight, posterior border slightly convex. Punctations numerous, single, smaller than one ommatidium. Prosternum anterior to procoxae narrower than length of one procoxa. Prosternal process sharply convex in side view, slightly expanded laterally between procoxae (Fig. 2D) and near apex. Procoxae separated by less than width of one coxa.

Pterothorax. Elytra strongly convex, widest near middle. Humeri as wide as posterior border of pronotum. Scutellar stria short, composed of 1 to 5 punctations. Scutellum small, triangular. The nine elytral striae composed of a series of narrow, deep punctations. Striae parallel, converging together near the apex. Stria 8 ending opposite middle of visible sternite 4. Strial pairs 1/9, 2/7, 3/6, and 4/5 joining near apex. Intervals flat. Apex of elytra narrowly rounded (Fig. 1B,D). Epipleuron short, ending at posterior margin of visible sternite 3, with a longitudinal carina near base. Mesepisternum with a few deep, broad punctations. Mesoventrite short, with a depression between coxae. Metaventrite very short, covered with fine yellow hairs. Discrimen joining in middle of metaventrite with oblique folds, forming a Y-shaped groove.

Abdomen. Abdominal ventrites with shallow punctations and fine yellow setae on sternites 6 and 7. Anterior projection of ventrite 1 between metacoxae broadly rounded.

Genitalia. Ovipositor long, soft, of 'coelometopine type' (Tschinkel & Doyen, 1980) (e.g. see Matthews & Doyen, 1989: fig. 3). Gonostyli pointing laterad. Coxite lobe 1 longer than lobes 2-4 combined. Paraprocts membranous, with transverse sclerotised baculi. Additional sclerotised baculi between paraproct baculi and base of proctiger present, about as long as length of paraproct baculus (Fig. 2G). Spiculum ventrale long and narrow. Spermatheca non-glandular, spherical, large, derived from apex of long, tube-like accessory gland. Accessory gland derived apically from saccate vagina. Defensive glands long, reaching anterior edge of abdomen, lacking dark, sclerotised helical thickenings typical of most Coelometopini, rather of the 'cnodalonine type' (Tschinkel & Doyen, 1980). Aedeagus with tegmen ventral at rest, rotated 180°. Median lobe adnate to tegmen (Fig. 2E,F).

Legs. Slender, relatively long, covered with fine yellow hairs (including coxae). Pilosity denser at apex of tibiae. Apex of femora usually darker in colour than base. Tibial spurs small, narrow and pointed, dark brown in colour. Tarsi covered with fine yellow setae dorsally. Penultimate tarsal segment always shorter than others. Ventral surface of first three tarsal segments (fore and midlegs) and first 2 segments of hind legs densely pilose (Fig. 2C). Apical and penultimate segments arcuately curved, less densely pilose ventrally. Empodium with several long parempodia.

DIAGNOSIS AND RELATIONSHIPS. Based on the features of the female genital tube (spherical spermatheca derived from the apex of the accessory gland), the ovipositor (basal coxite elongate, longer than coxites 2-4 together; transversal baculus of paraproct), as well as external anatomy (eyes reniform, separated by more than the width of a single eye; antennae with stellate sensoria on the apical 6 segments), there is no doubt that this genus belongs to the tenebrionid tribe Coelometopini (Tschinkel & Doyen, 1980; Doyen & Tschinkel, 1982; Doyen, 1989). The following characters are unique to *Cuemus* among Australian Coelometopini: very convex profile, long and thin antennae reaching the middle of the elytra, apical antennal segments not flattened, longer than wide. *Neotheca* Carter is the only other genus in Australia with the clypeal membrane completely exposed, but it does not have the anterior corners of the clypeus extending beyond the frontoclypeal suture (as found in *Cuemus*).

A preliminary phylogenetic analysis including representatives of about 50 Australo-Pacific genera (including the Australian region plus the Papuan and Pacific subregions of the Oriental region (sensu Gressitt, 1961)) within the tribe Coelometopini was carried out to look for potential relatives of *Cuemus*. Only two other flightless genera, *Micromenandris* Kaszab and *Asopidiopsis* Kaszab, both endemic to Fiji (Kaszab, 1955), possess the external and internal female features which characterise *Cuemus*. Externally, these genera also have a completely exposed clypeal membrane and the anterior corners of the clypeus extending beyond the frontoclypeal suture. The main feature uniting these three genera is that the extra baculi between the paraprocts and proctiger are about the same length as the paraproct baculi. Other genera in the region differ from *Cuemus*, *Micromenandris* and *Asopidiopsis* in having either no extra baculi at all or, if they are present, they appear either as a short, thin sclerotised membrane or as long baculi, distinctly longer than the paraproct baculi. According to the preliminary phylogenetic analysis, the group including *Cuemus* and the two related genera from Fiji form a monophyletic clade which is basal within the Coelometopini and sister to all other members of the tribe in this region.

The genus *Micromenandris* is very easily separated from the other two because it has 11 elytral striae as opposed to 9 in *Cuemus* and *Asopidiopsis*. The absence of lateral margins on the pronotum of the five described *Asopidiopsis* taxa (including two subspecies) will distinguish them at once from *Cuemus* species.

The genus *Microsphaerotus*, with two species from Vietnam (Masumoto, 1998), is similar to *Cuemus* and *Asopidiopsis* externally, however dissection of a female *M. ruficornis* Pic revealed important differences in the ovipositor and genital tube.

BIOLOGY. All known specimens of *Cuemus* are from rainforest vegetation and were collected either by hand at night on the surface of standing or fallen dead wood, or using a pyrethrum knockdown technique on tree trunks and logs (Baehr, 1995).

KEY TO SPECIES OF *CUEMUS*

1. Body dark brown, except for patch of lighter colour between striae 6 and 9 near elytral apex; hypomeron with shallow punctations; pronotum with rounded anterior corners and regular lateral borders; metepisternum with at most a few shallow punctations . . *monteithi* sp. nov.

Head and pronotum reddish brown, elytra light brown, with darker brown areas laterally near base and apically between striae 1 and 6; hypomeron with several deep, circular punctations; pronotum with angular anterior corners and irregular lateral borders; metepisternum with deep circular punctations . . . . . . *cooki* sp. nov.

Cuemus monteithi sp. nov.
(Figs 1A-B, 2A-G)

ETYMOLOGY. Named after the naturalist G. B. Monteith, insect curator at the Queensland Museum, who has contributed immensely to the knowledge of Australia's fauna and flora.

MATERIAL. HOLOTYPE: ♀, QMT16318, Bellenden Ker Range, N Qld, Cable Tower 3, 1054m, 17 Oct-5 Nov 1981, Earthwatch/Qld Museum [Expedition], Pyrethrum knockdown; ANIC, Coleoptera, Voucher No. 83-0978, (QM). PARATYPES: 1♀, Bellenden Ker Range, 1km S of Cable Tower 6, 1054m, 17 Oct.-Nov. 5 1981, 500m, Earthwatch/QLD Museum [Expedition], ANIC Coleoptera, Voucher No. 83-0977, (ANIC). 1♀, same as previous; QMT16319 (QM). 1♀, 17°23'S 145°46'E, Bartle Frere, W Base, 28 Nov. 1998, 750m, Monteith, Cook & Bouchard, night collection; QMT71048. (UQ). 1♀, 16°56'S 145°51'E, Mt Murray Prior summit, 7-8 Dec 1998. Monteith & Bouchard, QMT71049 (QM) (body disarticulated). 1♂, Bell Peak North, 10km E Gordonvale, 13 Oct. 1982, 850-1000m, Monteith, Yeates & Thompson. QMT16320 (QM).

DESCRIPTION. Head dark brown, apex of clypeus and basal part of labrum slightly lighter

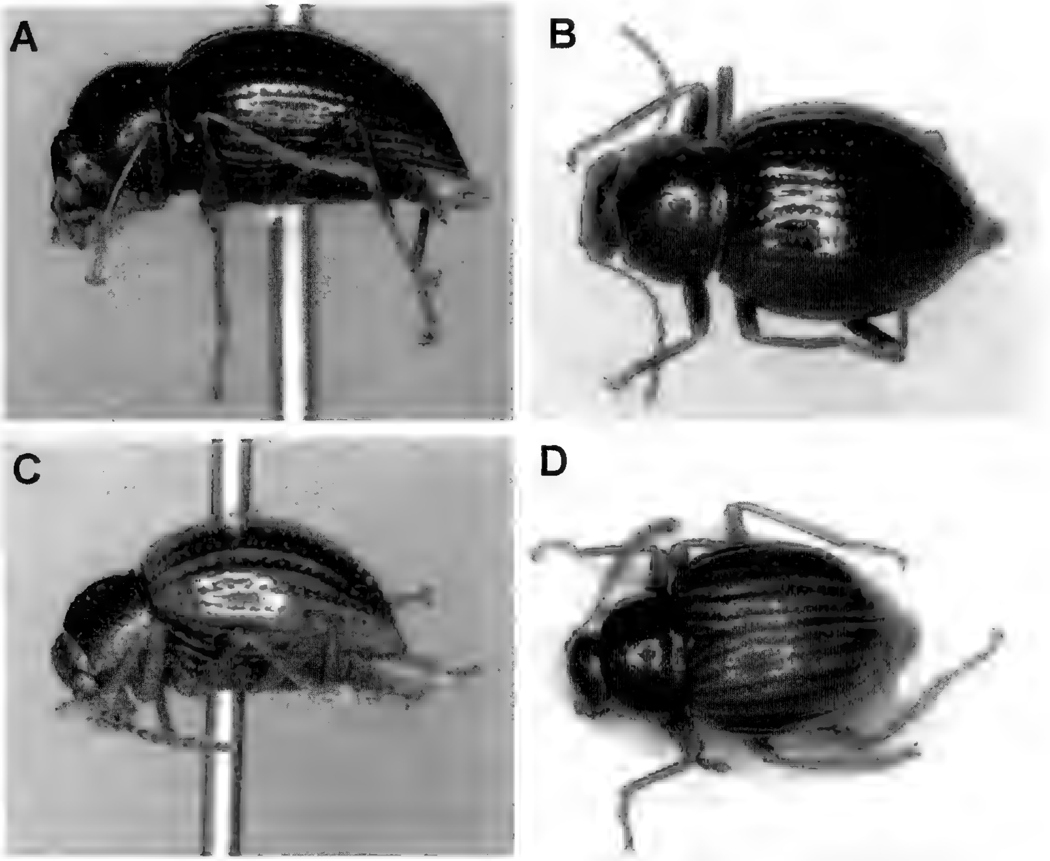

FIG. 1. A-B, *Cuemus monteithi* sp. nov., ♀; A, lateral view; B, dorsal view; C-D, *C. cooki* sp. nov., ♀; C, lateral view; D, dorsal view. (Photos: A. O'Toole).

in colour. Mouthparts and antennae light brown. Pronotum dark brown to reddish brown, with several circular punctations throughout. Hypomeron with shallow, circular punctations. Elytra dark brown, paler brown near apex between striae 6 and 9; strial punctations deep, usually with small darker circle around each one. Abdominal ventrites dark to reddish brown, with shallow punctations throughout; membrane between ventrites 3-4 and 4-5 light brown. Femora dark brown in colour, apices slightly darker. Tibiae dark brown, apices slightly lighter in colour, covered with fine yellow setae. Tarsi light brown. Tarsal claws reddish brown. Males identical to females externally.

MEASUREMENTS. Body length (from frons to apex of elytra), 5.35 (5.10-5.60); median pronotal length, 1.60 (1.44-1.55); maximum pronotal width, 2.05 (1.86-2.20); elytral length, 3.60 (3.40-3.50); maximum elytral width, 3.15 (2.80-3.20).

DIAGNOSIS. Distinguished from *Cuemus cooki* by its darker, more uniform colour, shallow punctations on hypomeron, rounded anterior corners of pronotum, regular lateral borders of pronotum and metepisternum lacking the deep circular punctations of *C. cooki*.

DISTRIBUTION. This species has been collected only in high elevation rainforests in the Bellenden Ker and Malbon Thomson Range rainforest zones of the northern Queensland wet tropics (Monteith, 1995) (Fig. 3). The two ranges are closely adjacent but separated by the deep valley of the Mulgrave river.

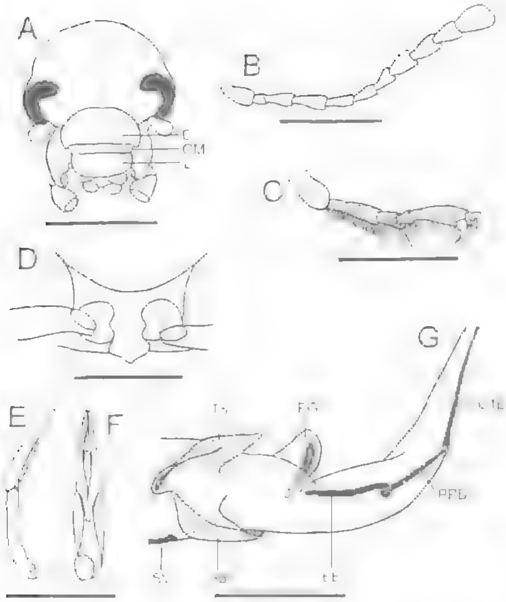

FIG. 2. *Cuemus monteithi* sp. nov.; A, head; B, left antenna; C, left hind tarsus; D, prosternum; E, aedeagus, lateral view; F, aedeagus, dorsal view; G, ovipositor. Scale bar, 1mm. Abbreviations: C, clypeus; C1B, coxite 1 baculus; CM, clypeal membrane; EB, extra baculus; L, labrum; PG, proctiger; PPB, paraproct baculus; S8, sternite 8; SV, spiculum ventrale; T8, tergite 8.

Cuemus cooki sp. nov.
(Fig. 1C-D)

ETYMOLOGY. Named after Douglas Cook, also of the Queensland Museum, who assisted collection of the only specimens of this rare species.

MATERIAL. HOLOTYPE: ♀, QMT16316, Mt Finnigan, NE Qld, 760m, via Helenvale, July 20-27 1974, G. Monteith & D. Cook; rain forest, nocturnal, hand collected (QM). PARATYPE: ♀, same as holotype, QMT16317 (SAM).

DESCRIPTION. Head reddish brown, apex of clypeus and basal part of labrum slightly lighter in colour. Mouthparts and antennae light brown. Pronotum reddish brown, with several deep, circular punctations throughout. Hypomeron with several deep, circular punctations. Elytra light brown, with slightly darker areas laterally near base and apically between striae 1 and 6; strial punctations deep, with small darker circle around each one. Abdominal ventrites light brown, with shallow punctations throughout and distinct crenulations near anterior border of ventrites 1 to 3; membrane between ventrites 3-4 and 4-5 lighter in colour. Legs light brown, with areas slightly darker in colour near apex of femora. Tarsal claws reddish brown apically. Male not available.

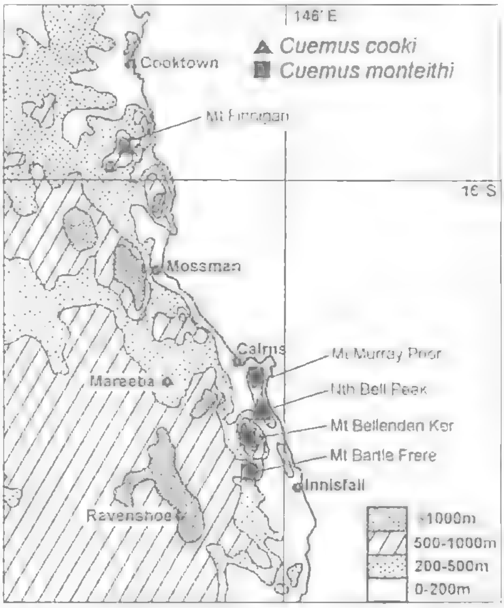

FIG. 3. Distribution of *C. monteithi* sp. nov. and *C. cooki* sp. nov. in northeast Queensland.

DIAGNOSIS. Separated from *Cuemus monteithi* by its colour (reddish brown on head and pronotum, combined with a light brown colour for the rest of the body, except for two slightly darker areas on elytra), denser and deeper punctations on hypomeron, angular anterior corners of pronotum, lateral borders of pronotum with irregularly undulate and metepisternum with deep circular punctations.

MEASUREMENTS. Body length (from frons to apex of elytra), 4.60 (4.60); median pronotal length, 1.16 (1.10); maximum pronotal width, 1.84 (1.70); elytral length, 3.00 (2.90); maximum elytral width, 2.85 (2.65).

DISTRIBUTION. This species has only been collected once in rainforests on the summit of Mount Finnigan (Fig. 3).

ACKNOWLEDGEMENTS

Thanks to the curators listed for loans of specimens and to my supervisors, D.K. Yeates and G.B. Monteith for their support and helpful comments. J. Skevington, S. Winterton and K. Evans provided helpful comments on the manuscript. A. O'Toole provided the photographs for Figure 1. Many thanks to K. Masumoto (Institute of Living Sciences, Otsuma Women's University, Japan), O. Merkl (Dept. Zoology, Hungarian Natural History Museum, Hungary) as well as E.G. Matthews (South Australian Museum, Australia) for suggesting potential related genera of *Cuemus*. Funding was provided by FCAR (Fonds pour la formation de Chercheurs et l'Aide à la Recherche, Canada), OPRS (Overseas Postgraduate Scholarship, Australia) and UQPRS (University of Queensland Postgraduate Scholarship, Australia).

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DISTRIBUTION, BIOLOGY AND CONSERVATION STATUS OF THE PEPPERMINT STICK INSECT, *MEGACRANIA BATESII* (KIRBY) (PHASMATODEA: PHASMATIDAE), IN QUEENSLAND

M. CERMAK AND J.W. HASENPUSCH

Cermak, M. & Hasenpusch, J.W. 2000 12 31: Distribution, biology and conservation status of the peppermint stick insect, *Megacrania batesii* (Kirby) (Phasmatodea: Phasmatidae), in Queensland. *Memoirs of the Queensland Museum* **46**(1): 101-106. Brisbane. ISSN 0079-8835.

Megacrania batesii was studied in the Wet Tropics region of north Queensland. Its natural history and distribution is reviewed and supplemented by observations in the field and in captivity. Surveys found a substantial, sexually-reproducing population at Cape Tribulation in a range of habitats. Three parthenogenic populations south of Cairns are confined to small patches of habitat adjacent to beaches. The reliance of *M. batesii* on *Pandanus* was confirmed and the range of *Pandanus* species eaten was expanded. The species is under no immediate threat but fits the IUCN criteria for Vulnerable on the basis that its population occurs over an area of less than 100km^2 and could be further threatened if any one subpopulation is extirpated. ❒ *stick insects, Phasmatodea, Megacrania, survey, Pandanus, parthenogenesis, conservation, Queensland, Australia.*

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The Peppermint Stick Insect, *Megacrania batesii* (Kirby), is a poorly known phasmid that, in Australia, has a restricted and patchy distribution in tropical northeast Queensland (Franzmann, 1974; Rentz,1996) and the Sir Edward Pellew Islands in the Gulf of Carpentaria (Key, 1991; Rentz , 1996). This species is the sole representative of the subfamily Platycraninae in Australia (Key, 1991; Rentz, 1996; Vickery, 1983). Its type locality is the Solomon Islands (Kirby, 1896) and this author also refers to museum specimens from Malayan and Papuan islands, Aru and Kei Dulan, Philippines, Goram, Gilolo, Amboina and New Guinea, though it is clear he had reservations about the conspecificity of some. Modern published records for *Megacrania batesii* outside Australia include the Solomon Islands (Chia-Chi Hsuing, 1991; Vickery, 1983) and New Guinea (Van Herwaarden, 1998).

The first Australian specimens of *M. batesii* were collected at Etty Bay, north Queensland in 1971 and at Mission Beach in 1973 by Franzmann (1974). This author also described the peppermint secretion which the species squirts from two gland openings on the prothorax when disturbed, and illustrated the position of the gland openings. This secretion does not effect human skin (Franzmann, 1974) but irritates the eyes on contact (J. Seymour, pers. comm. Jan. 1999). Franzman (1974) also commented that only females were ever found at these localities. Rentz (1993) draws attention to the vulnerable status of the species in Australia and refers to the Etty Bay population as being near 'Mackay' which is a lapse for Innisfail. No *M. batesii* males have been found south of the Daintree River, so the southern populations were assumed to be parthenogenic (Rentz 1996). The same author first refers to the presence of males in some populations, notes the peculiar locomotion of the species in which only the fore and mid legs are used, and records the foodplant as *Pandanus tectorius*. Brock (1999) also mentions that parthenogenic and bisexual populations occur along a few coastal parts of North Queensland and illustrates the eggs for the first time. However he incorrectly describes its locomotion as involving only the fore and hind legs. A line illustration is given of an Australian *Megacrania* by Key (1991) and colour photographs have been published by Rentz (1996), Hughes (1996) and Brock (1999).

This study aims to determine the full extent of the species' distribution in the wet tropics of North Queensland and to determine its conservation status. Observations of living specimens in the field and in captivity between 1991 and 1999 provided additional information on the behaviour and defence mechanisms of the species.

MATERIALS AND METHODS

Field surveys were conducted between November 1998 and February 1999. Preliminary surveys confirmed the presence of *M. batesii* at Cape Tribulation, Etty Bay and Bingil Bay (north of Mission Beach) (Fig. 1). Subsequent surveys were conducted to determine the limits to those three populations, and to identify other suitable areas containing *Pandanus* plants along the Wet Tropics coast.

Surveys were conducted by searching for partially defoliated *Pandanus* plants either from a vehicle or on foot. Presence/absence of *M. batesii* was recorded upon close examination of the plants. Chew marks caused by other insects feeding on *Pandanus* were recorded for comparison and a collection of *Pandanus* eating insects was compiled for future reference.

Survey sites were chosen by examining characteristics of known sites and choosing locations with broadly similar characteristics. In some areas along the coast north of the Daintree River, access was difficult. In these situations, surveys were conducted by searching transects along the Cape Tribulation road and coastal beaches; if *M. batesii* were found then transects were walked perpendicular to the beach and/or the road. These perpendicular transects were of no set length but were terminated 100m beyond the last occurrence of *M. batesii*. Some areas of the coastline (e.g. the northern aspect of Cape Kimberley) were totally inaccessible so were not surveyed. However all other accessible areas containing *Pandanus* between Donovan Range in the north and Tully Heads in the south (Fig. 1) were surveyed. Some areas of coast between the Daintree River and Bramston Beach were deemed unsuitable for *Megacrania* because of the lack of *Pandanus* or of suitable forest type. Proposed survey in the Yarrabah region, south of Cairns (which contains suitable habitats) was not possible. Forest types surveyed were characterised on the criteria of Tracey & Webb (1975) and Tracey (1987).

Observations of behaviour and predation were conducted opportunistically while surveying the distribution of *M. batesii*. Feeding and mating trials were conducted in the laboratory by introducing the insects onto different species of *Pandanus* and *Freycinetia*.

Body length measurements were obtained from a sample of 10 adult males from Cape Tribulation and 14 adult females (7 from Cape Tribulation and 7 from Etty Bay).

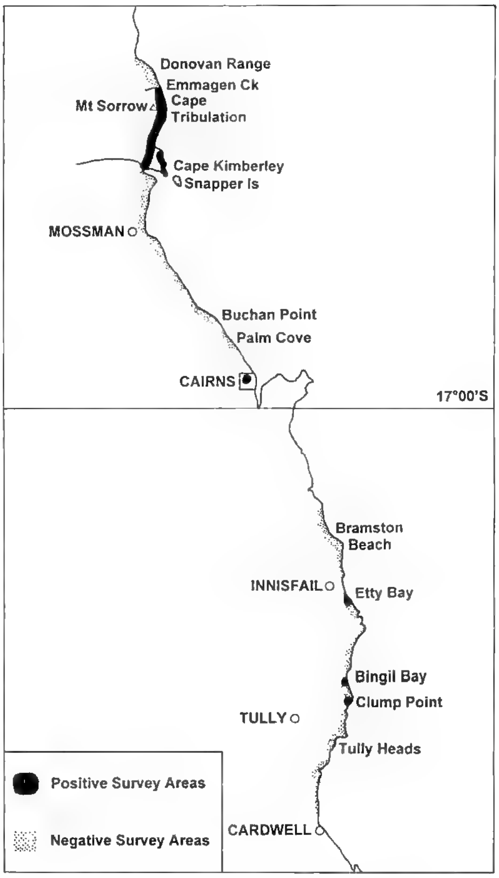

FIG. 1. Map of part of the Wet Tropics region of Queensland showing distribution of *Megacrania batesii* (Kirby). Presence of colonies is shown in black. Areas surveyed, but which proved negative, are shown stippled.

The length and width of eggs collected from Cape Tribulation, Etty Bay and Bingil Bay populations (sample size range 9-13) were measured using Vernier calipers. Width was regressed against length which was then used to compare differences among populations using a one-way ANOVA. In July, when newly emerged nymphs were abundant, we counted all *M. batesii* feeding on 40 *Pandanus* plants and calculated the average number of individuals supported by a single plant.

RESULTS AND DISCUSSION

DISTRIBUTION AND HABITAT. *Megacrania batesii* was found at five locations from Cape Tribulation to Clump Point (Fig. 1, Table 1). The

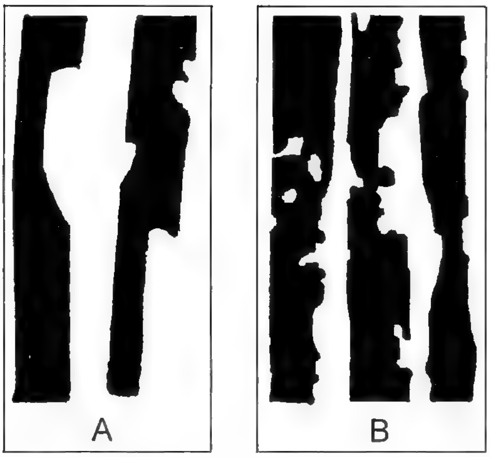

FIG. 2. Feeding marks on leaves of *Pandanus*; A, caused by *Megacrania batesii*; B, caused by the katydid, *Austrosalomona* sp.

Cape Tribulation population is confined to an area between the Daintree River in the south and Emmagen Creek in the north. *M. batesii* occur in *Pandanus* beside all types of shore line in this area. No *M. batesii* were found on Snapper Island or in suitable habitat with the host plant along the coastline between the Daintree River and Cairns.

Four separate populations of *M. batesii* were found south of the Daintree River. The Etty Bay population was located at the southern end of the beach and on the eastern aspect of the adjacent coastal range. Extensive searches north, south and inland of this area failed to locate any *Megacrania*. The Bingil Bay population, 30km to the south of Etty Bay, occurs over an area of 3ha extending 1.5km along the beach and 20m inland to the eastern edge of the Clump Mountain National Park and North Bingil Bay. A further 2.3km south of Bingil Bay, the Clump Point population occurs over an even smaller area of about 100m^2. A small population of *M. batesii* was also located in the Cairns Central Swamp in the suburb of Manunda within the City of Cairns. However this probably results from releases of captives by insects enthusiasts in Cairns (M. Trenerry, pers. comm. Jan. 1999).

South of Cairns, *M. batesii* appears to be restricted to areas where rainforests are adjacent to beaches. At Cape Tribulation, however, it was recorded beside rainforest streams or swamps up to 5km inland and at up to 300m altitude on Mt Sorrow. The phasmids frequently inhabit *Pandanus* growing on the seaward edge of beach vegetation. These plants are regularly subjected to sea water spray, particularly during windy conditions at high tide, suggesting a high tolerance of salt.

The natural populations of *Megacrania* lie in high rainfall foci where annual rainfall exceeds 3000mm and driest quarter exceeds 160mm (Rainforest CRC, 1998). The presumably introduced colony in Cairns lies outside these rainfall levels.

FOOD PLANTS. During the survey, we observed *M. batesii* feeding on three species of *Pandanus* in the wild, *P. tectorius* Parkinson, *P. monticola* F.v.Muell. and *P. soloms-laubachii* F.v.Muell. In captivity, *M. batesii* fed on two other native species (*P. whitei* Martelli, and *P. gemmifer* John) neither of which occur in the natural range of the phasmid. It also accepted the related climbing genus, *Freycinetia*, and the exotic species, *Pandanus utilis*.

At Clump Point, *Megacrania* was recorded on *P. tectorius* (the only *Pandanus* species present), while at Bingil Bay and Etty Bay *Megacrania* fed on both *P. tectorius and P. monticola*. At Cape Tribulation, the phasmids utilised three species, *P. tectorius*, *P. monticola* and *P. soloms-laubachii*.

The feeding scars caused by *M. batesii* are readily distinguished from those of the few other insects that eat *Pandanus*. Typically, *M. batesii* bites into the leaf on a slight angle from the margin towards the mid rib and then proceeds longitudinally, back to the margin (Figs 2A, 3B). By comparison the feeding scars of orthopterans (*Austrosalomona*,Tettigoniidae) tend to be more circular (Fig. 2B). The chewing patterns were used to detect *M. batesii*, particularly on tall, inaccessible plants. The first and second instar nymphs were found on young growth of the food plant, while adults mainly feed on older leaves.

DENSITY. Census of 40 occupied *Pandanus* plants in the field at Etty Bay and Bingil Bay revealed that a single leaf cluster typically supported 1 to 5 nymphs of instars 1 to 3 (mean 2.3, SE 0.197). We recorded no more than 3 adults per leaf cluster but M. Trenerry (pers. comm. 1999) reported up to 10 adults and sub-adults on one leaf cluster at Etty Bay. Heavy feeding damage to a young plant is shown in Fig. 3D.

REPRODUCTION AND DEVELOPMENT. The Cape Tribulation population contains both males and females, while the southern populations appear to reproduce by parthenogenesis

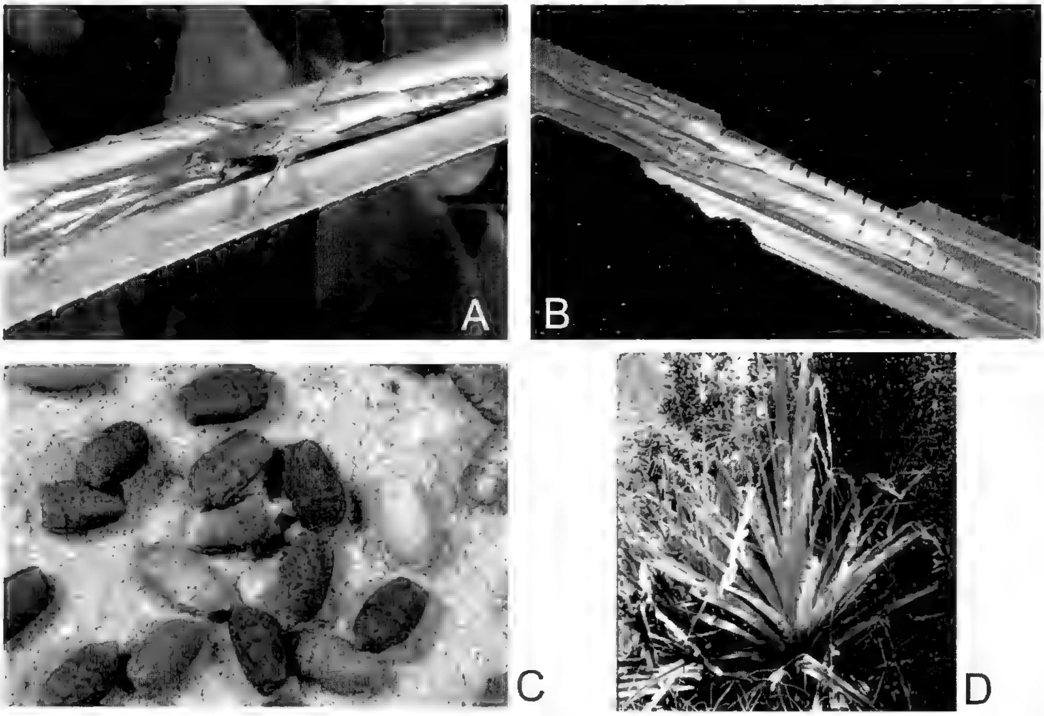

FIG. 3. *Megacrania batesii*. A, active adult ♀ on *Pandanus* leaf (Cape Tribulation); B, resting ♀ and last instar nymph on *Pandanus* leaf – note position of legs and feeding marks on leaf margins; note colour pattern of nymph (Etty Bay); C, eggs (Etty Bay); D, severe phasmid feeding damage to a juvenile *Pandanus* plant (Cooper Creek, Daintree).

given that no males were ever observed. Several males from Cape Tribulation readily mated with females from Etty Bay in the laboratory, but the resultant eggs did not hatch.

Megacrania batesii appears to have an annual life cycle. In the field at Cape Tribulation eggs were released from November to April and hatched from July to December. Adults then peaked from December to March. By July 1999 at the same locality there were abundant nymphs of all instars but an almost total absence of adults. However, during subsequent observations at Cape Tribulation in July 2000, *Megacrania* were abundant in all developmental stages including adults.

Eggs are shown in Fig. 3C. In captivity, parthenogenic females from Etty Bay produced between 60 to 70 eggs in their lifetime. Unlike many phasmids, *Megacrania* do not throw their eggs with a flick of the abdomen at the moment they are released. The relatively large eggs were dropped haphazardly to the ground or on to the leaves of the host plant. The eggs often rolled down into the spiral centre of the *Pandanus* plant, where they were eventually covered and secured by frass from feeding adults. In time, a fungal growth cemented the frass into a solid mass in the axils. Examination of four medium sized *Pandanus* leaf clusters revealed a mean of 27.3 eggs trapped within the foliage of each plant.

There was a significant correlation between egg length and width ($R=0.495$, $p=0.003$), so only length data were used in further analysis. Eggs are very large, varying in length from 7.1-8.15mm (mode 7.79-7.91mm: 39.4%). There were no differences in egg length between populations (ANOVA, $F=1.2$, $df=2$, $p=0.32$), and the eggs appeared to have identical sculpturation and colour.

Mean body length of females at Etty Bay (111.0mm ± 0.95, $n=7$) was not significantly different to that of females at Cape Tribulation (106.9mm ± 1.22, $n=7$; $T=2.65$, $0.02<p<0.05$, $df=12$), but these were longer than males

TABLE 1. Geographical locations and classification of forest types (Tracey & Webb 1975) inhabited by *Megacrania batesii*.

Location	Forest type	Description	Coordinates
Cape Tribulation	1a	Complex Mesophyll Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	2a	Mesophyll Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	17	Coastal Beach Ridges and Swales	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	13a	Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Cape Tribulation	13d	Vine Forest	16°02'>16°14'30"S, 145°25'>145°28'25"E
Etty Bay	2a	Mesophyll Vine Forest	16°34'S, 146°05'30"E
Bingil Bay	2b	Mesophyll Vine Forest	17°49'45">17°50'15"S, 146°05'40">146°06'E
Clump Point	2b	Mesophyll Vine Forest	16°51'25"S, 146°07'E
Cairns C. Swamp		Fringing Mesophyll Vine Forest Swamp	16°55'S, 145°45'E

(75.3mm ± 0.96, $n = 10$; $T=1.96$, $0.01<p<0.05$, df=15).

BEHAVIOUR. Adults and nymphs of *M. batesii* rest within the deep groove on the upper surface of *Pandanus* leaves, or on the underside. They adopt a distinctive posture with front and mid legs stretched forward and hind legs directed backwards (Fig. 3B). While feeding, they assumed a position along the leaf margin and when disturbed, shuffled backwards to the centre of the plant using only their front and mid legs. Though both sexes are winged, *M. batesii* do not fly. The males, being more gracile and having longer wings, are capable of parachuting to the ground when disturbed. Females do not attempt to fly at all.

Most of the stages of *M. batesii* are well camouflaged on the green foliage. However, the last nymphal instar is quite conspicuous with most individuals being bright blue-green with dark segmental margins, yellow, red and black eyes, and red antennae and wing buds (Fig 3B).

PREDATORS. The following predators were observed feeding on *M. batesii*: huntsman spiders (Sparassidae), jumping spiders (Salticidae), centipedes (Scolopendrida), green tree ants (*Oecophylla smaragdina* Fabricius), praying mantids (*Hierodula majuscula* Tindale), katydids (Tettigoniidae) and Black Butcher Birds (*Cracticus quoyi* Lesson).

PARASITES. Some eggs from all three sub-populations were parasitised by a species of chalcidoid wasp, *Anastatus sp* (Eupelmidae: Eupelminae), identified by Dr Chris Burwell of the Queensland Museum. These gregarious endoparasitoids have brachypterous females and macropterous males. *Anastatus* are primary parasitoids of a wide variety of insects including Blattaria, Hemiptera, Homoptera, Lepidoptera, Mantodea, Neuroptera, Orthoptera and Phasmida (Gibson, 1995). A total of 56 wasps emerged from 5 *M. batesii* eggs in July 1999 (range: 8-15, sex ratio: 1 male/6 females).

CONSERVATION. *Megacrania batesii* in north Queensland has so far been found to occur in five isolated populations in humid coastal habitats on the eastern aspect of the coastal escarpment between Mission Beach in the south and Emmagen Creek just north of Cape Tribulation. Even if *Megacrania* existed in those few inaccessible areas between Daintree River and Emmagen Creek that were too difficult to survey, they would still be located well within the Cape Tribulation population boundaries. Under IUCN criteria the species would meet the criteria for Vulnerable: D2 because their range is restricted to less than 100km^2 and could be endangered if any of the populations are extirpated.

The Cape Tribulation population, in particular, is under no threat because of the abundance of suitable habitat and because the core of the population is essentially protected within the Cape Tribulation National Park. The Etty Bay population appears to be relatively secure as it occurs within the Johnstone Shire's Conservation Area and is also situated within the Wet Tropics World Heritage Area. The Bingil Bay, Clump Point and Cairns Central Swamp populations are distributed over very small areas and therefore are of some conservation concern.

To fully evaluate the conservation status of the species, DNA assay of the existing populations would be very valuable. This would not only determine whether the four populations comprise a homogenous species or more than one taxonomic unit, but would also shed light on their geographic relationships. If genetic differences between the five *M. batesii* populations is small, then we can assume that the species is more mobile than we suspect, and therefore presents little conservation concern. However, if the populations are genetically distinct, then they may represent declining remnants and conservation management should be applied. DNA analysis would also shed light on whether the Cairns Central Swamp population is introduced and, if so, from where.

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THREE NEW SPECIES OF CHIRONOMIDAE (DIPTERA) FROM THE AUSTRALIAN WET TROPICS

P.S. CRANSTON

Cranston, P.S. 2000 12 31: Three new species of Chironomidae (Diptera) from the Australian Wet Tropics. *Memoirs of the Queensland Museum* **46**(1): 107-127. Brisbane. ISSN 0079-8835.

Two new genera and three new species of Chironomidae are described from Australia in all life history stages: in the subfamily Orthocladiinae: *Echinocladius* gen. nov., type species *E. martini* sp. nov.; in the Tanypodinae: *Australopelopia* gen. nov., type species *A. prionoptera* sp. nov. and in the Chironominae: *Polypedilum australotropicus* sp. nov. All species occur in streams of the Wet Tropics, where they are the subject of ongoing ecophysiological study. *E. martini* and *A. prionoptera* have a wide distribution in cool, shaded eastern submontane streams, inferred to reflect a Gondwanan-type distribution. In the case of *Echinocladius* this is supported by a postulated phylogenetic sister-group relationship to *Pirara* Boothroyd & Cranston, already known from Australia and New Zealand, and now with a third species decribed here, *Pirara edwardi* sp. nov., from Patagonian Argentina. The erection of a new genus of pentaneurine Tanypodinae, *Australopelopia*, also is justified by phylogenetic reasoning, with a sister group relationship to a more widely defined *Thienemannimyia*-group of genera postulated. *Polypedilum australotropicus* is differentiated from Australian congeners, with a new larval feature, a hyaline area postulated to be the clypeal section of the frontoclypeus, figured and discussed. ❒ *Chironomidae, Orthocladiinae, Tanypodinae, Chironominae, tropics, Australia, Argentina.*

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The Australian chironomid (Diptera: Chironomidae) fauna is well enough known on a continental scale (Cranston, 1996, 2000) to allow some understanding of ecological and biogeographic relationships. We can recognise taxa: i) related to those in other cool areas of the southern continents; ii) related to those in warmer gondwanan areas; or iii) non-gondwanan, including anthropogenic, elements derived more recently from the north. Assessing the correctness of previous taxonomic placements depends upon a global perspective, and increasingly upon the availability of all life history stages to allow appropriate phylogenetically-based ecological and biogeographic understanding. Still, however, detailed study of the biota of a poorly-studied part of the Australian continent reveals undescribed, unallocated or misallocated taxa, and the Wet Tropics of North Queensland is no exception (Cranston, 1999, 2000). Some of these chironomid taxa are the subject of evolutionary-based research, for example in ongoing studies of the eco-physiological responses of ecologically and biogeographically-contrasting lotic chironomid taxa (Brendan McKie, in prep.). Three of the taxa involved represent different subfamilies, biogeographic origins, functional feeding groups and physiological responses. This contribution provides formal names and descriptions for taxa for which codes have been used previously. Phylogenetic estimates made in support of decisions are based on on-going data matrix constructions available from the author on electronic request.

METHODS

Specimens were collected from streams by individual larval collection, or from drift using a modified Surber sampler with mesh size of approximately 300μm, for an exposure period that minimally included the night hours (18.00-6.00h). Sorting was done in the field immediately after net recovery using a binocular microscope and natural light where possible. Individual larval rearings were made in native water, held at ambient temperature, in separate vials stoppered with cotton wool. Specimens were prepared with at least the genitalia of pharate adults dissected out and mounted in Euparal, or some whole larvae in Hoyer's mountant. Terminology follows Sæther (1980) except for use of taenia (taeniate) for broadened thin setae (Langton, 1994). Mensural features are counts, or lengths in μm unless stated. Localities are

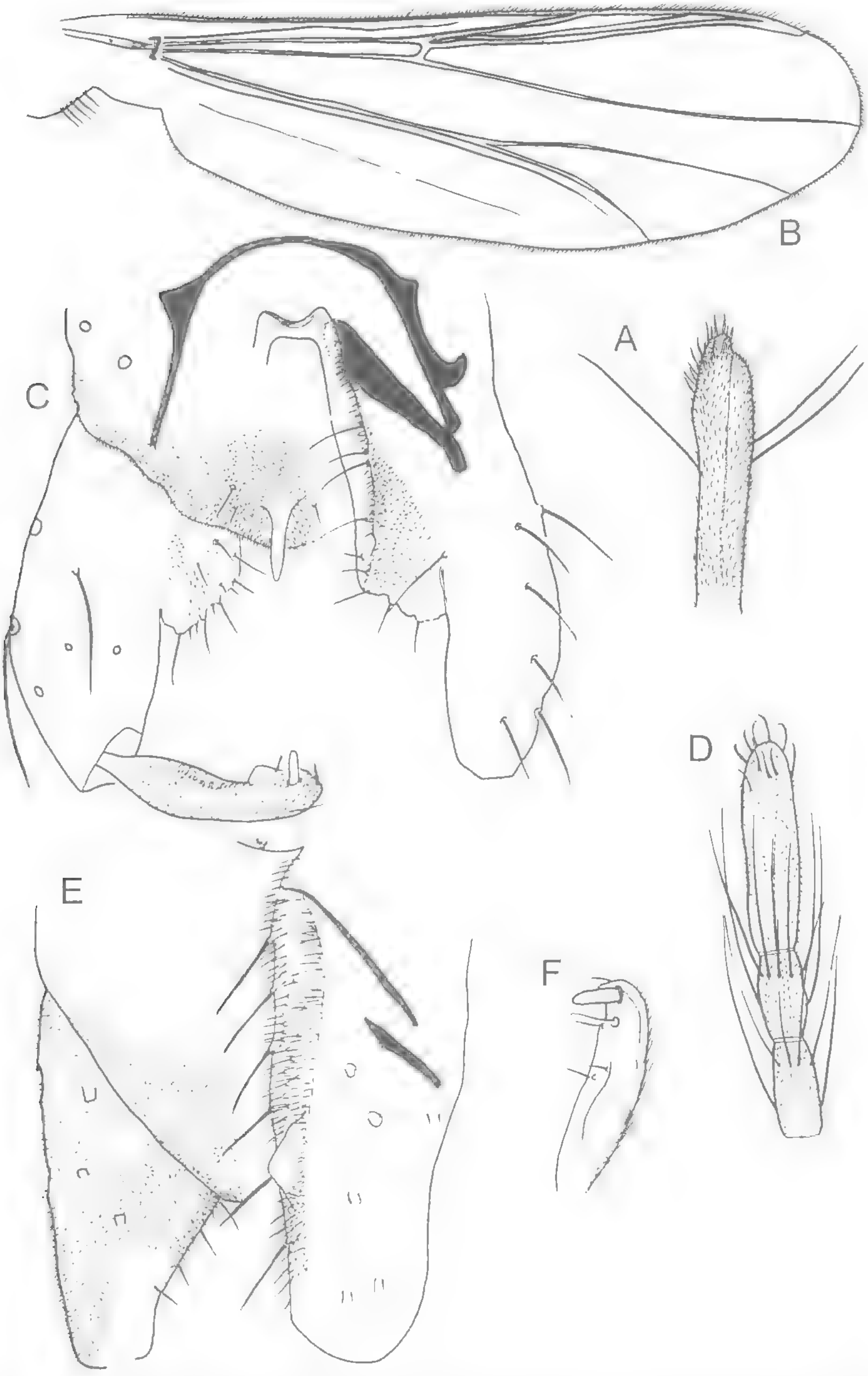

FIG. 1. A-C, *Echinocladius martini* sp. nov., ♂; A, antennal apex; B, wing; C, ♂ genitalia, left side dorsal, right side semi-internal. D-F, *Pirara edwardi* sp. nov., ♂; D, antennal apex; E, ♂ genitalia, left side dorsal, right side semi-internal; F, gonostylus, isolated, left, mesal.

arranged from N to S: either GPS-derived degrees, minutes and seconds (xx°xx'xx") or decimal minutes (xx.x') are cited. Elevations, where cited, are map-derived. Unless stated otherwise, the collector is the author, and specimens are deposited in the Australian National Insect Collection (ANIC), Canberra. Specimens are entered into the ANIC database. Abbreviations: AR, antennal ratio (terminal flagellomere [or 2 in Tanypodinae]: remainder of flagellum); L(e), larva (exuviae); LR, leg ratio (tarsomere1: tibia); NP, National Park; P(e), pupa (exuviae); SF, State Forest.

SYSTEMATICS

ORTHOCLADIINAE

Echinocladius gen. nov.
(Figs 1-4)

Orthocladiinae 'MO5' Cranston, 1996, 2000; McKie & Cranston, 1998.

TYPE SPECIES. *Echinocladius martini*, sp. nov.

ETYMOLOGY. *Echino*, Latin for thickly set with spines, as is the pupa, and *cladius*, Latin for a diminutive branch (clade).

DIAGNOSIS. Adult with kidney-shaped eye, thorax with well-developed antepronotum, lacking acrostichals, wing with R_{2+3} compressed between R_1 and R_{4+5}, tarsi with pulvilli, hypopygium with short bare anal point, with inferior volsella. Pupa lacks frontal setae, has mutiplied dorsocentral setae, carries dense fine spines on tergites and sternites, and the short anal lobe has macrosetae comprising 3 stout short spines. Larva purple in life, having large dilate Lauterborn organs, a 6-segmented antenna, simple, broadly lanceolate SI seta; pecten epipharyngis with 3 unfused rounded scales; mandible apical tooth shorter than combined width of 4 inner teeth; mentum with simple, broad median tooth with median nipple and 5 pairs of evenly decreasing lateral teeth.

DESCRIPTION. MALE. Small, length up to 2.1mm; wing length to 1.2mm. Antenna with 13 cylindrical flagellomeres, well-developed plume extending to apex lacking strong subapical seta (Fig. 1A); groove extending from flagellomere 4 to 13; sensilla chaetica on flagellomeres 2-5 and sub-apex of 13. AR c.0.5. Head with kidney-shaped bare eye without dorsomedial extension. Temporal setation restricted to few linear postorbitals. Tentorium tapering apically, strongly dilated in basal section, with distinct sieve plate, cibarial pump rectangular with short cornua. Clypeus densely setose. Palps with 5 segments, 2nd longer than subequal 3-4, 5th longer; 3rd without sensilla chaetica.

Thorax uniform medium brown. Antepronotum well developed, lobes not medially narrowed, narrowly in medial contact. Thoracic setation: 0-2 antepronotals, acrostichals absent, few dorsocentrals and prealars; few uniserial scutellars. Pleurae bare.

Wing (Fig. 1B) membrane with fine punctation, without macrotrichia. R_1 running close to R_{4+5} with R_{2+3} visible but compressed between, ending close to apex of R_{4+5}, above M_{3+4}; costa extended. Brachiolum with 1 seta, R with few setae, remaining veins without setae. Squama with few setae. Anal lobe moderately produced. FCu far distal to r-m, Cu_1 curved, with slightly recurved apex, strong to wing margin.

Legs with fore tibial spur shorter than tibial apex, median tibia with two short, subequal spurs; hind tibia with one long spur subequal to tibial apex, the other short; mid- and hind spurs weakly denticulate; comb disorganised; pseudospurs absent. Sensilla chaetica apparently absent. Pulvilli well developed, at least half claw length, claws apically slightly pectinate.

Abdomen with unicolorous tergites, with few, long, setae concentrated in anterior half of tergite; tergite IX with few apical setae. Anal point narrow, bare, placed posteriorly on tergite and projecting beyond apex of tergite. Sternapodeme an inverted U-shape, with weak to strong anterolateral projections; phallapodeme well developed. Hypopygium (Fig. 1C) lacking superior volsella; inferior volsella elongate-triangular, with rounded posterior lobe. Gonostylus simple, with megaseta and small crista dorsalis. Virga absent.

FEMALE. As for male, except body length 1.9-2.6mm, wing length 1.1-1.4mm. Antenna (Fig. 2A) with 5 flagellomeres; AR 0.44-0.64. Head with 2-3 outer vertical/postorbitals. Wing (Fig. 2B) with R, R_{2+3} and R_{4+5} darkened, closely appressed although veins distinct, with R_{4+5} continuing distinctly into costal extension; R, R_1 and R_{4+5} setose; venarum ratio 1.32-1.43; squama with 7-9 setae. Claws simple. Genitalia (Fig. 2C, D) with tergite IX small, weakly emarginate medially, with single row of posterior setae or some signs of aggregation into two clusters; gonocoxite IX weakly bulging, with many long and short setae; gonapophysis VIII divided, large ventrolateral lobe overlying posterior part of

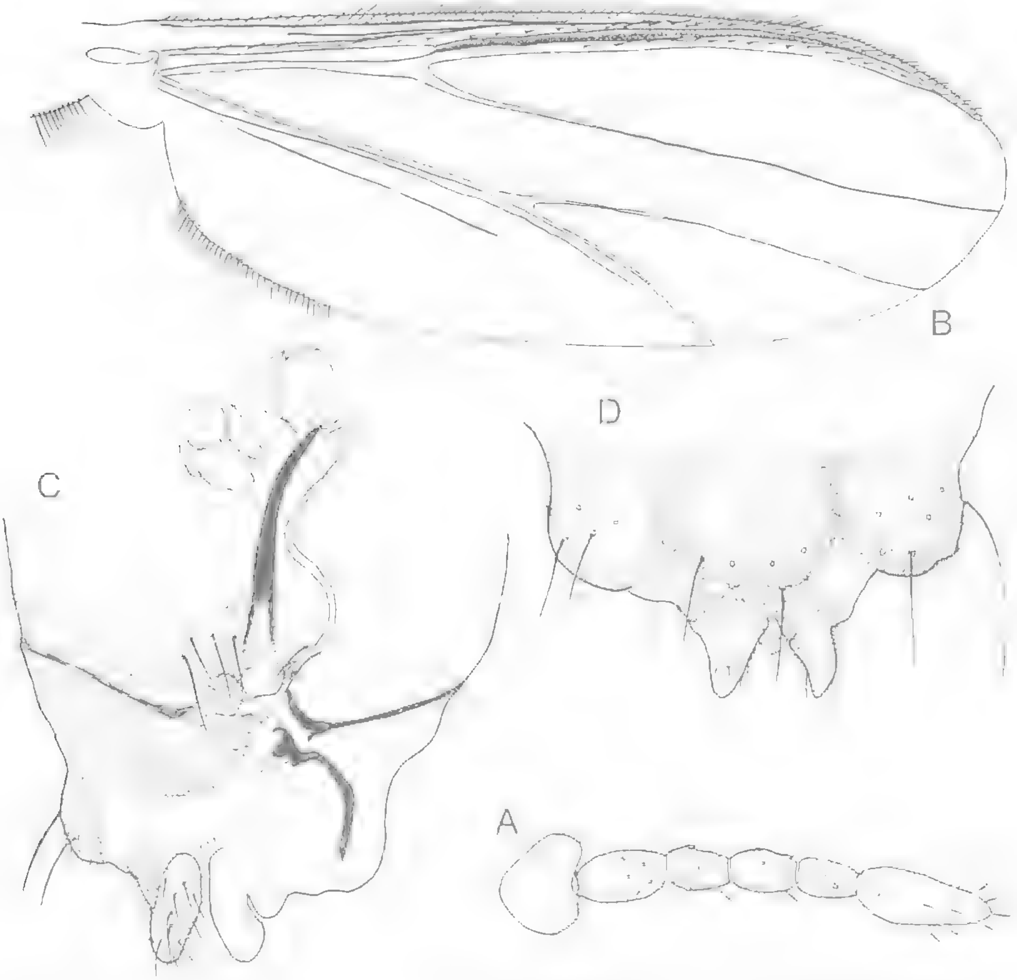

FIG. 2. *Echinocladius martini* sp. nov., ♀; A, antenna; B, wing; C, ♀ genitalia, ventral; D, ♀ genitalia, dorsal.

strong dorsomesal apodeme lobe dark, quite large, weakly curved to interrupted medially; notum moderately lengthed, extending no further anterior than posterior seminal capsules; 2 seminal capsules pale, ovoid to pear-shaped, without microtrichia, with well developed neck; spermathecal ducts curved with pronounced bulbs before separate openings; labia simple and weakly sclerotised. Tergite X and cerci small, postgenital plate triangular.

PUPA. Small, 3-4mm. Exuviae uniformly grey-brown. Cephalothorax: frontal setae absent but possibly represented by paired scars on frons. Frontal apotome smooth. Ocular field with one vertical and one postorbital seta. Thorax with 2 median and one lateral antepronotals, 3 subequal precorneals; with numerous thoracic setae not readily allocated to conventional groups (Fig. 3A). Thoracic horn absent. Dorsum of thorax variably rugulose. Prealar area rounded, with c. 10 setae. Wing sheath smooth.

Abdomen without pedes spurii A and B. Tergites (Fig. 3B,C): predominantly without shagreen (may be faint on II) II without hook row, II-VIII with posterior transverse spine band with some medial spines pale and very elongate, IX with median patch of long dark spines. Conjunctives II-IV with long translucent anteriorly-directed slender spines, often very dense, medially divided on IV. Sternites (Fig. 3C) with or without fine shagreen, when present, notable on posterior segments; II with cluster of long translucent spines medially. Conjunctives III-V with dense long translucent anteriorly directed fine spines. Anal lobe small, squared-off, with antero-median patch, of long and short spines, with 3 subequal short, stout macrosetae (Fig. 3D), much shorter than anal lobe. Male genital sac extends posteriorly beyond anal lobe; that of female much shorter. Setation: generally 5 D, 4 L and 6-8 V setae.

LARVA. Fourth-instar larva medium-sized, up to 5.8mm long. Dorsal surface of head with single frontoclypeal sclerite, partially fragmentary posteriorly, smooth anteriorly. Antenna (Fig. 4A) 6-segmented, with 3rd subequal to 2nd, 4th and 5th short, 6th minute. AR c 1. Ring organ at base of segment 1; antennal blade simple, extending to sub-apex. Lauterborn organs well developed, dilate, subequal in length to segment 3, style half length of 3rd segment. Labrum (Fig. 4B) with SI simple, broadly lanceolate, SII long, slender, SIII and IVa,b simple and short, one chaeta lanceolate, remainder simple; spinulae strong. Premandible with one apical and one small but broad inner tooth, with weak premandibular brush. Pecten epipharyngis of 3 unfused rounded scales, the median one apparently either serrate, or notched, or both. Ungula short and squat with few short and simple and pectinate chaetae. Mandible (Fig. 4D) with outer and inner margins smooth, apical tooth shorter than combined width of 4 inner teeth. Seta subdentalis present, more or less rounded. Seta interna with 2 simple branches. Mentum (Fig. 4C) with median tooth simple and broad with median nipple; 5 pairs of lateral teeth decreasing on even slope. Ventromental plate narrow, basally overlying bulbous to ledge-shaped projection ventral to outermost mental teeth and extending nearly to outermost mental tooth (extent depends on degree of compression); beard absent. Maxilla (Fig. 4E) with squat palpiger, few galear lamellae, without pecten galearis, with one large triangular lacinial chaeta. Body with no evidence of lateral setae. Anterior parapods separate, with crown of elongate, simple, spines and small pectinate claws. Posterior parapods separate, with apical group of simple claws. Procercus as wide as high, dark pigmented posteriorly bearing 3 (perhaps 4) shortish anal setae. Anal tubules scarcely developed.

DISTRIBUTION. Monotypic, Australian/Tasmanian endemic, distributed along the eastern sub-coastal continental margin from 17°S to 42°S.

REMARKS. In Freeman (1961), males of *Echinocladius* key to *Kiefferophyes* Freeman based on the bare eye, outer tibial spur short relative to inner, non-macrotrichiose, finely punctate wing membrane, fringed squama and wing vein R_{2+3} distinct though ending close to apex of R_{4+5}. Comparison with *Kiefferophyes* shows there is a superficial resemblance, but the genitalia differ especially in significant features in *Echinocladius* such as the lack of a strong virga, lack of any indication of a gonostylar extension and presence of simple, bare anal point. Freeman's (1961) coverage of the Australian Orthocladiinae is incomplete, and several taxa of 'small, black midges' are excluded. In the key to Holarctic adult Orthocladiinae (Wiederholm, 1989) *Echinocladius* belongs to a group with bare wings and eyes, fringed squama, small pulvilli and lacking acrostichals, amongst which it keys to *Psilometriocnemus* Sæther (at least to the species *triannulatus* Sæther) if the anal point is considered parallel-sided, or *Tvetenia* Kieffer if it is considered to taper.

The female of *Echinocladius* keys readily to *Parorthocladius* in Sæther (1977) who suggests that *Kiefferophyes* might run to this couplet. Although the female genitalia of *Kiefferophyes* remains undescribed, Sæther's deduction undoubtedly was correct, as was his speculation that the female genitalia might appear 'more similar to *Limnophyes*'. The resemblance of *Echinocladius* to *Kiefferophyes*, whose immature stages remain unknown and are therefore likely to be terrestrial, is discussed above.

Pupae of *Echinocladius* lack frontal setae and thoracic horns and always have many prealars and multiple thoracic setae, have dense abdominal armament including long needle-like or triangular spines on posterior of most tergites including IX, sternal conjunctives III-V with elongate pale needle-like spines, fine L-setae, and anal lobe rounded/truncated with 3 short macrosetae and without fringe. *Echinocladius* pupae key in Wiederholm (1986) to *Limnophyes* Eaton or *Paralimnophyes* Brundin, based on the distinctive presence of very elongate ('needle-like') spines on the tergites. However, this feature actually has a wider distribution amongst exuviae of presumptive Gondwanan orthoclad taxa, including *Botryocladius* Cranston & Edward, 1999, *Pirara* Boothroyd & Cranston, 1995 and some Australian taxa known thus far by codes,

FIG. 3. A-D, *Echinocladius martini* sp. nov., pupa; A, thorax lateral; B, tergites, dorsal; C, abdomen, lateral; D, anal lobe setae. E, *Pirara edwardi* sp. nov., tergites, dorsal.

namely 'SO2' and 'SO3' (Cranston, 1996). That *Echinocladius* is neither a *Limnophyes* nor a *Paralimnophyes* can be inferred on pupal features from the very short and spine-like anal lobe macrosetae (in contrast to the conventional anal lobe setal length), the distinctive distribution of the needle-like setae especially on tergite IX and sternites, and the multiplicity of thoracic setae. These features, and lack of a thoracic horn eliminates both *Botryocladius* and 'SO2' from consideration. The taxon 'SO3' has conventional thoracic setation, lacks a thoracic horn, and has less developed tergal spines: the most similar pupal taxon is *Pirara* which shares much similarity of armament, differing predominantly in possessing frontal setae and in the conventional thoracic setation.

Echinocladius larvae have a 6-segmented antenna of moderate-length with exceptionally dilate Lauterborn organs that equal the length of the 3rd segment, itself subequal to the 2nd segment; S1 seta simple, as are all other S setae, labral lamellae absent, premandible simple and without beard, mentum with domed single median tooth; ventromental plate bulging but not extending beyond outer margin of mentum without setae beneath; mandible with 4 distinct inner teeth, smooth outer and inner surface and mola, with slender, 2-3 branched seta interna. In Wiederholm (1983) the larva fails to key due to an apparent irreconcilable character conflict, in that all included taxa with a simple S1 seta apparently have reduced procerci. In reality this is misleading since *Tokunagaia* does possess this combination of features (as does *Echinocladius*) but is incorrectly keyed: nevertheless *Tokunagaia* probably is not a close relative since the antenna, mentum and ventromental plate differ markedly. The ventromental plate shape of *Echinocladius* is reminiscent of *Limnophyes* and *Paralimnophyes*.

In providing an estimate of phylogenetic relationships for *Botryocladius*, Cranston & Edward (1999, table 6) scored a morphological matrix for putative relatives including *Echinocladius* (as 'MO5') but without *Pirara*. Parsimonious analysis of that matrix with the addition of *Pirara* suggests that this genus forms the sister taxon to *Echinocladius*, and this pair are sister to *Paralimnophyes* either alone or with *Synorthocladius* (see Cranston & Edward, 1999, fig. 11 for tree without *Pirara*). Revisiting *Pirara* showed that *P. australiensis* Boothroyd & Cranston actually does have a short, hyaline anal point, in contrast to the original description, figure and key (Boothroyd & Cranston, 1995). Furthermore, amongst Patagonian (South American) lotic drift net material there occurs pharate material belonging to this clade, and since this aids in generic delimitation and confirms a cool temperate biogeographic scenario (Boothroyd & Cranston, 1995), the species is described briefly as *Pirara edwardi* sp. nov. in this contribution.

Echinocladius martini sp. nov.
(Figs 1-4)

ETYMOLOGY. The specific epithet honours Australian colleague Jon Martin, who first associated the pupa and adult of this taxon by rearing.

MATERIAL. HOLOTYPE. Le/Pe/♂, Australia, 35°22'S 148°50'E, ACT, Blundell's Ck, ix.1999, ex-wood surface, reared Cranston, in ANIC. PARATYPES. Queensland: P♂, 3Pe, 17°01'S 145°35'E, nr Mareeba, Davies Ck above falls, 520m, 11/12.iv.1997, 6Pe, 19/20.vi.1997, 7Pe, 27/28.viii.1997, 4Pe, 17/18.xii.1997; 14Pe, 17°08'06"S 145°35'35"E, Danbulla, Kauri Ck, 17/18.xii.1997; P♀, Pe, 17°20'S 145°28'E, Herberton, Carrington Falls Ck, 800m, 9/10.iv.1997; L, 6Pe, 17°26'48"S 145°28'28"E, Nigger Ck, 1100m, 19.xii.1997; 2Pe, 18°11.7'S 145°46.0'E, Yuccabine Ck, 10.vi.1997 (McKie); 4Pe, 18°58.0'S 146°09.8'E, Camp Ck, 12/13.vi.1998 (McKie); 2Pe, 18°58.7'S 146°09.8'E, Mary Ck, 9.ix.1997 (McKie); Le/Pe/♂, P♂, 18°58'S 146°09'E, Paluma, Birthday Ck, 1000m, 24.x.1998 (McKie), 26Pe, 18°59'S 146°09'E, 25/26.iii.1998; 2Pe, 19°01'S 146°13'E, unnamed Ck S Paluma, 850m, 25/26.iii.1998; Pe, Eungella NP, Mt Dalrymple track, Cattle Ck, 950m, 22.iii.1998; 4Pe, 26°03'00"S 153°04'29"E, Coloola NP, Frankis Gulch, 6.iv.1996. NSW: 2Pe, 30°16'S 152°50'E, nr Dorrigo, Eve Ck, 9.x.1996; Pe, 31°54'S 151°34'E, Barrington Tops, Dilgry R.,14.iv.1990; 2Pe, 34°40'S 150°44'E, Barren Grounds N.R., Redback Stream, 9.iv.1994; 8Pe, 35°16'S 150°03'E, Morton NP, Wog Wog Ck, 25.iv.1994; Pe, 35°24'S 149°57'E, Mongarlowe R., 7.iii.1992, Le/Pe/♂, 15.iii.1992, 3Pe, 17.iii.1992; Pe, 35°23'S 149°55'E, Monga SF, Mongarlowe R., 2.ii.1991; Le/Pe/♀, 35°26'S 150°12'E, Bimberamala Ck, 28.ix.1996; Le/Pe/♂, Le/Pe/♀, 35°31'S 150°03'E, Clyde SF, Carter Ck, .x.1996; 2L, 6Pe, 35°34'S 150°02'E, Currowan SF, Cabbage Tree Ck, 30.iii.1994; Pe, 35°33'S 149°58'E, Clyde Mt., Sugarloaf Ck, 20.xii.1987, Pe/♂, Pe, 10.i.1988; Le/Pe/♀, 35°35'S 150°05'E, Paddy's R., 16.x.1993; PG, 35°35'S 149°28'E, Captains Flat. Molonglo R., 30.i.1988 (Atkins); Pe, 35°45'S 149°57'E, SE Araluen, Deua R., 19.xii.1990; Pe, 37°16'S 149°40'E, Mt Imlay, Imlay Ck, 13.i.1994. ACT: Brindabellas, PG, 35°20'S 148°56'E, Pierce's Ck, 23.i.1996, ex-wood (McKie); Le/P, PE, 35°22'S 148°50'E, Pe, Blundell's Ck, 26.iii.1988, 2Pe, 8/9.iv.1988, Le/Pe/♀, 13-16.iv.1988, Pe, 3.viii.1998, Pe, 24.i.1998 (Willis); Pe, 35°20'S 148°56'E, Lees Ck, 21.v.1998, Pe, 12/13.i.1998 (Willis & Cranston), Pe, 24.i.1998 (Willis), Pe, 16/17.vi.1998; Le/P♂, 2Le/Pe/♀, 35°25'S 148°47'30"E, Moonlight Hollow, 20.x.1991; Pe, 35°27'S 148°57'°, Tidbinbilla Ck, 19.ii.1989; Pe, 35°39'S 148°598'E, Namadgi NP, Orroral R., 21.ii.1988; L(P), 35°41'S 149°00'E, Gudgenby R., 14.ii.1988. VIC: Pe, 36°33'S 147°23'E, Mitta Mitta, Snowy Ck, 10.ix.1990 (Cook); Pe, 37°14.5S 148°45.5'E, East Gippsland, jct Bonang Hwy/gap Rd, Bonang R., 15.ii.1992; Pe/♂, 37°28'S 145°45'E, Steavenson R., 7.iv.1993 (Downes). TAS: Pe/♂, Lake St Clair, at entrance of Narcissus R., 9.x.1972

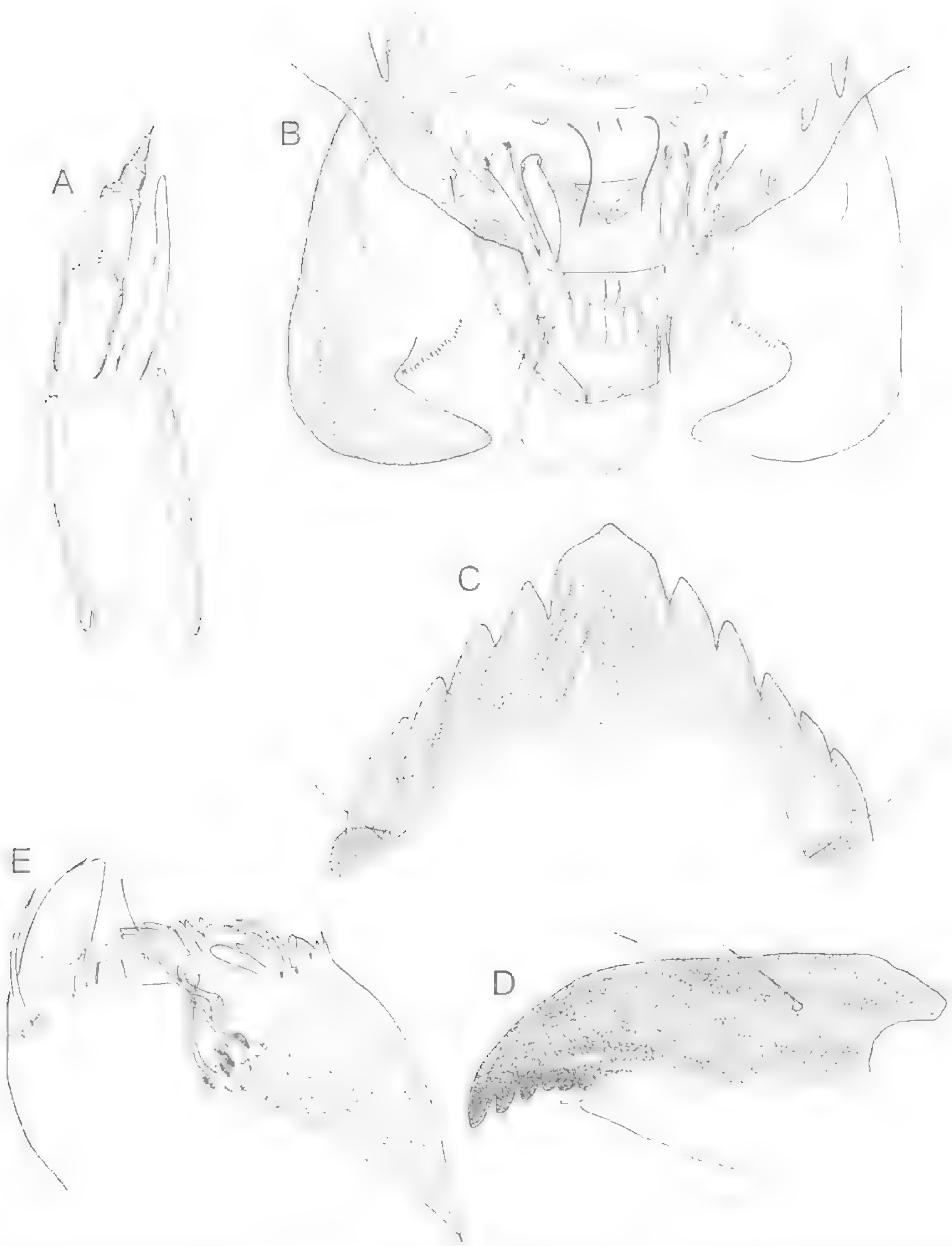

FIG. 4. *Echinocladius martini* sp. nov., larva; A, antenna; B, labrum; C, mentum; D, mandible; E, maxilla.

(Martin); L, Pe, 42°38.5'S 146°34'E, Mt Field NP, Twilight Tarn, 1000m, 7.ii.1992; 2Pe, 42°40.5'S 146°37.5'E, Lake Fenton, 1006m, 6.ii.1992; 2Pe, 42°40'S 146°35'E, Lake Seal, 900m, 7.ii.1992; 2Pe, 42°40.5'S 146°37.5'E, Lake Newdegate, 1140m, 6.ii.1992.

DESCRIPTION. MALE. (n=3) Thorax, legs and abdomen brown-black. Body length 1.6-2.1mm, wing length 1.0-1.3mm. Antennal segments 1-12: 375-430, 13: 215-320, AR 0.55-0.76. Head with 2 strong outer verticals and 1 postorbital, 10-13 clypeals. Palp 2-5, 20-30, 45-65, 60-80, 100-130. Thoracic setation: 1 lateral antepronotal; 0 acrostichals; 6-10 dorsocentrals, 3-4 prealars: 0 supraalars; 3-8 biserial scutellars. Wing setation: Sq 7-10, R 1-4; V.R. 1.32-1.43. LR_1 0.54-0.57, LR_2 0.39-0.44, LR_3 0.48-0.51. Hypopygium, as in Fig. 1C, gonocoxite 80-160, gonostylus 55-101.

FEMALE. (n=2) Body length 1.6-1.9mm, wing length 1.2-1.4mm. Antennal segments 45, 28, 35, 32, 60; AR 0.42-0.56. Head setation: 0 frontal, 2-3 strong postorbitals, 15 clypeals. Thoracic setation: 0-1 lateral antepronotal; 0 acrostichals; 7-9 dorsocentrals, 3 prealars: 0 supraalars; 7-8 biserial scutellars. Wing setation: Sq 6-9, R 6-8, R_1 6-8, R_{4+5} 18-20; V.R. 1.5. LR_1 0.59, LR_2 0.39-0.42, LR_3 0.46-0.49. Seminal capsules 60 × 56, ovoid, with short neck.

PUPA. (n=10) Length 2.2-2.9mm, cephalothorax 800-820mm. Frons without frontal setae. Thorax as Fig. 3A, abdomen as in Fig. 3B,C. Anal macrosetae 20-25 long (Fig. 3D).

LARVA. (n=10) Length 3.2-3.5mm, thoracic segments green, abdomen pale blue anteriorly tending to violet posteriorly. Head capsule length 260-315, pale, with occipital margin slightly darker, lateral mental teeth and inner mandibular teeth golden brown. Antennal segment lengths: 27-42, 9-12, 9-12, 3-4, 3-4, 2; AR 1.06-1.45. Blade 20-30, style 8-10, Lauterborn organ 9-11. Mentum width 49-75, median tooth 9-10. Mandible 77-107. Procercus 17-22 × 12-14, bearing 4 anal setae of maximum length 130-145.

DISTRIBUTION, ECOLOGY AND BIOGEOGRAPHY. *Echinocladius martini* is quite abundant in flowing waters, predominantly where shaded from elevated temperatures, from north Queensland, to southeast Australia and Tasmania, especially at middle to high elevations. In southeast Australian subalpine streams larval *E. martini* (as 'MO5') were amongst the most abundant chironomids living as gatherers on immersed wood in streams with riparian native vegetation, with abundances little reduced in streams with riparian pine plantation, but almost absent from otherwise comparable unshaded grassland streams (McKie & Cranston, 1998). In Birthday Creek at 1000m above sea level in the southern Wet Tropics, *E. martini* larvae are abundant at the water/surface interface, where they form translucent silken tubes, which are also used for pupation (B. McKie pers. comm.).

As with several other cool stenothermic Orthocladiinae, this predominantly lotic species occurs in standing waters at high elevations in Tasmania, where lower temperatures and aerating effects of wave action probably ensure favourable conditions.

As assessed by interception of floating pupal exuviae, *E. martini* adults emerged only in late summer/early autumn in a southeastern subalpine stream (Willis, 1998). Dates from serendipitous 24 hr drift net collections suggest that this seasonality is widespread in temperate areas, whereas in tropical Queensland exuvial collections supplemented with observations by McKie suggest essentially continuous emergence.

The evident sister group relationship to *Pirara*, and relationship to *Paralimnophyes*, *Botryocladius* and 'SO2' and 'SO3', a clade with strong gondwanan connections, suggests that *Echinocladius* also belongs in this biogeographic grouping. Not only does the phylogeny suggest this historical relationship, but the modern day distribution and ecology of the clade also carries the same inference. Taxa with phylogenetic relationships to New Zealand and Patagonian South America, as with *Echinocladius*, all share the same cool stenothermic physiology, and distribution along the eastern coast of Australia in shaded (and therefore cool and well oxygenated) streams. The same applies to *Australopelopia* (see below).

Pirara edwardi sp. nov.
(Figs 1D-F, 3E)

ETYMOLOGY. For D.H.D. (Don) Edward, recently retired chironomidologist of Western Australia, accompanist of the author to Patagonia in 1997, in acknowledgment of his companionship in field and laboratory.

MATERIAL. HOLOTYPE. P♂, Argentina: 16km S San Martin, Arroyo Partida, 21.i.1997, P.S. Cranston, in Museo de la Plata, Argentina. Holotype and paratypes, P♂, P♀, same locality, both mounted on one slide.

DESCRIPTION. MALE. (n=2, pharate) Thorax, legs and abdomen brown-black. Mensural features. Body about 2mm, wing length unmeasurable. Antenna (Fig. 1D) with segments 1-12: 445-450, 13: 77-82, AR 0.17-0.18. Head setation: 0 frontal, 3 strong postorbitals, 6-8 clypeals. Thoracic setation: 0-1 lateral antepronotal; 0 acrostichals; 5-6 dorsocentrals, 3 prealars: 0 supraalars; 4-5 biserial scutellars. Wing setation: Sq 8, remainder unmeasurable. LR uncalculable. Hypopygium (Fig. 1E) with densely microtrichiose tergite IX, with only 2 modest setae, apparently without anal point (although if short and hyaline, the anal point may be present and hidden in a crease in tergite IX of the teneral specimens, as with *P. australiensis*, above).

Gonocoxite 125-132 with no indication of superior volsella, inferior volsella with hyaline rounded-triangular apex, gonostylus (Fig. 1F) 50-53, without crista dorsalis. Virga weakly indicated, phallapodeme short, sternapodeme very thin. Gonocoxite dorsally with 6 long setae aligned along median border, overlapping with those of the opposite gonocoxite.

FEMALE. undescribable from early pharate pupa.

PUPA. (n=3) About 2mm long, essentally indistinguishable from the two described species of *Pirara* from Australia and New Zealand, and separable from *Echinocladius* by the 4 dorsocentral setae, and sparser tergal spinosity, including the presence of a broad gap in the median area of tergite III (Fig. 3E).

LARVA. Unknown, but predicted by its congenericity in other stages, to possess the autapomorphies of *Pirara*, notable the plumose submental, external mandibular and maxillary setae.

REMARKS. From re-examination of the described species of *Pirara*, and the material of *P. edwardi* above, the following features distinguish between the two genera:

The adult male of *Echinocladius* has well developed pulvilli, whereas *Pirara* has no trace; the wing of *Echinocladius* has R_{2+3} distinct between R_1 and R_{4+5} although they are approximated for all their length, obviously so in the female wing, whereas, although R_1 and R_{4+5} are well separated in *Pirara*, R_{2+3} is indistinguishable; *Echinocladius* has no virga, but a weak to moderately-developed virga is seen in *Pirara*; the claws of *Pirara* are toothed apically, at least *P. australiensis*, simple in *Echinocladius*.

In the pupa, *Echinocladius* lacks frontal setae, but they are fine and small in *Pirara*; the dorsocentral setae are highly duplicated in *Echinocladius*, with the conventional number and placement in *Pirara*.

In the larva, although the large Lauterborn organ is shared, the antenna of *Pirara* is 5-segmented and short, but 6-segmented and of more normal length in *Echinocladius*; the median mentum comprises a domed tooth in *Echinocladius*, double in *Pirara*; the mandible of *Echinocladius* has 3 inner teeth, compared to the 4 of *Pirara*; *Echinocladius* lacks the prominent plumose cephalic setae of *Pirara*, and labral S1 seta is simple in *Echinocladius* but bifid in *Pirara*.

TANYPODINAE

Australopelopia gen. nov.

(Figs 5-6)

Pentaneura sp. Cranston 1996, 2000.

TYPE SPECIES. *Australopelopia prionoptera* sp. nov.

ETYMOLOGY. Australo, for the so-far endemic distribution in Australia, and pelopia, a frequently used suffix in Tanypodinae, based on the suppressed Meigen 1800 genus name *Pelopia*.

DIAGNOSIS. Adult with thoracic tubercle, scape and pedicel setose, costa spinose in G, extending beyond apex of R_{4+5} to near wing apex; R $_{2+3}$, R_2 and R_3 present; tibial spurs 1, 2, 2, elongate with several side teeth; hypopygium with evidence of volsella on median base of gonocoxite. Pupa with dilate tubular thoracic horn, with horn sac filling half lumen, with subapical connection to large ovoid plastron plate, filling much of corona; thoracic comb present; tergal scar present; shagreen of simple spinules, some aligned in rows; L(ateral) setae taeniate on VII and VIII, anal lobe outer marrgin spinose, inner bare, setae adhesive. Larva without swim hairs on body, head index c. 0.7; ligula 5-toothed with concave tooth row and inner teeth curved outward; 2nd antennal segment annulate, AR <4; Mandible with long seta subdentalis arising in indentation between projecting inner and basal teeth; SSm, V9 and V10 aligned at 45° to antero-ventral axis, with VP posterior to V10, dorsal pit present, S7 close to S8.

DISTRIBUTION. Monotypic, Australian/ Tasmanian endemic, distributed along the eastern margin, from 17°S to 41°S, and in extreme southwestern Western Australia.

REMARKS. All stages of *Australopelopia* conform to diagnoses of the tribe Pentaneurini, but each differs in generic identity according to respective stage keyed. The key to larval Pentaneurini of the Holarctic region in Wiederholm (1983) is subjective in some features (e.g. 'low' vs 'medium-sized' mandibular basal teeth, 'weakly' vs 'strongly' concave ligula) leading to some ambiguity in interpretation. For example, *Australopelopia* runs to couplet 26 in which the only mutually exclusive feature requires assessment of the relative size — 'large' vs 'without large' — of the basal mandibular tooth. There is even uncertainty about whether the structure in question is indeed a basal tooth, or just an extension of the mola around the site of insertion of the seta interna. However, accepting that the basal tooth is large, then the outwardly curved inner teeth of the ligula and simple parapod claws lead to *Pentaneura* Philippi or *Telopelopia* Roback. It resembles the latter more in having shorter anal tubules and procerci, non-linear, coarsely granulate pseudoradula, but differing in the shape of the muscle attachment area. Alternatively, if it is considered to be without a large basal mandibular tooth, then subsequently an irreconcilable combination of features is encountered — although the ring organ of the palp lies in the middle third (admittedly at the anterior end), the pseudoradula does not link to any sclerotised area, and the pecten hypopharyngis teeth are homogeneous in size, precluding identity with *Trissopelopia* or *Hudsonimyia*. The alternative couplet would lead to some *Thienemannimyia*-series genera, none of which have as strongly developed inner/basal mandibular teeth as the taxon under consideration.

The aforementioned key does not take into account the taxonomically valuable feature of the relative positions of the cephalic setae and sensory pores whose intra-generic invariance and inter-generic diagnostic value was recognised by Kowalyk (1985). Notable amongst these are the ventral cephalic setae S9, S10, Seta submenti (SSm) and the ventral pit (VP) which alone can distinguish amongst Australian taxa of Pentaneurini (Cranston, 1996). Following Kowalyk's key for Pentaneurini possessing simple basal palp segment and concave ligula (couplet 14 onward), the approximation of S7 and S8, and presence of a dorsal pit leads to *Telopelopia* and the *Thienemannimyia*-series. The alignment of S10, antero-lateral to S9, essentially precludes *Pentaneura* from consideration (*Pentaneura* sp., Kowalyk 1985, figs 140, 141; *Pentaneura inconspicua*, *P.* ? *cinerea* Cranston pers. obs.).

The pupa, lacking stellate or indeed any branched spinules in the abdominal shagreen, keys in Wiederholm (1986) beyond the *Thienemannimyia*-series. The possession of adhesive anal lobe setae and a thoracic comb directs towards *Trissopelopia* Kieffer or *Paramerina* Fittkau, but matches neither precisely. Major problems concern reconciling the shagreen pattern (of *Trissopelopia* type), with the spinosity of the anal lobe (of *Paramerina*-type).

The male adult keys in Wiederholm (1989) beyond the *Thienemannimyia*-series if the hypopygium is considered to lack a volsella, and to *Telmatopelopia* Fittkau if the costa ending is considered close to above M_{1+2}. The female keys in Sæther (1977) to *Conchapelopia* based on the microtrichiose labia and curved coxosternapodeme, but lacks the setae on gonotergite IX. If the coxosternapodeme is considered straight, then *Thienemannimyia* and perhaps other related genera enter consideration.

From the above it appears that each life history stage keys to a different grouping, although there is a recurring link to the *Thienemannimyia*-series of genera, comprising some 8 poorly-differentiated, generic-ranked taxa. The keys did not purport to follow phylogenetic lines, and indeed the only suggestions of Tanypodinae phylogeny are some tentative remarks by Sæther (1977), and thus the only answer to this dilemma is to attempt a phylogeny of the relevant groupings. Thus a matrix of 32 characters scored for 23 taxa has been compiled and analysed under parsimony. Character selection includes all phylogenetically informative characters noted in the section above, plus those cited by Murray (1995) in consideration of placement of a somewhat anomalous *Conchapelopia* species, together with some from female genitalia (Sæther, 1977) and some from Kowalyk's (1984) study of head capsule setation and pits. This ongoing study, which is preliminary and is not presented in detail here, consistently supports the broadest recognised *Thienemannimyia* group (Sæther, 1977), with a sister group relationship to *Ablabesmyia*. Perhaps not unexpectedly given the discussion above, it is proposed that *Australopelopia* is sister to the *Thienemannimyia* group, a placement that is independent of outgroup used: namely either or all of *Coelopelopia* (Coelopynini), *Natarsia* (Natarsini) or *Apsectrotanypus* (Macropelopini). The previous identification of this taxon as a species of *Pentaneura* (Cranston, 1996) is rejected on this evidence. The proposed phylogeny suggests that the weak expanded area medio-basally on the gonocoxite might be considered to be a precursor of the well developed volsellae that essentially defines the enlarged *Thienemannimyia*-clade, that is, including *Telopelopia*, and with *Ablabesmyia* as sister to this group.

The following description includes features of taxonomic significance at generic level. Until further species are collected, the species description of *Australopelopia prionoptera* summarises features of the new monotypic genus.

Australopelopia prionoptera sp. nov.

(Figs 5,6)

ETYMOLOGY. *Prion*, Greek for saw, and *pteron*, Greek for wing, in reference to the saw-toothed anterior wing margin of the adult male.

MATERIAL. HOLOTYPE. Le/Pe/♂, 18°58'S 146°09'E, Queensland: Paluma, Birthday Ck, 24.x.1998, reared McKie, in ANIC. Holotype, and paratypes as follows: Queensland: 2Pe, 16°02.7"S 145°27.0'E, Daintree, Emmagen Ck, 9/10.ix.1997 (McKie); Pe, 16°05.08"S 145°27.36'E, Mason Ck, 23.iv.1999; P♂, 16°28'S 145°19'E, Mossman, 1st unnamed Ck nr Rex Ck, 5/6.iv.1997, L, Pe, 17/18.xii.1997, 5L, 19/20.x.1998 (Cranston & Dimitriadis), 8Pe, P♂, P♀, 2nd unnamed Ck nr Rex Ck, 5/6.iv.1997; 2L, 3Pe, 16°34'S 145°20'E, Mt Lewis, Churchill Ck, 6/7.iv.1997; 2P♂, 16°35.2'S 145°17.5'E, Mary Ck, 8.ix.1997; 6Pe, 16°56.2'S 145°37.0'E, Shoteel Ck., 9/10.ix.1997 (McKie), 3Pe, 17.iv.1999; 2Pe, 16°59'S 145°38'E, Clohesy R., 7/8.1997 (McKie); Pe, 17°01'S 145°35'E, nr Mareeba, Davies Ck above falls, 11/12.iv.1997, 2Pe, 19/20.vi.1997, 4Pe, P♀, 17/18.xii.1997; 3Pe, 17°06.3'S 145°35.9'E, Danbulla, Kauri Ck, 11.vi.1997; L, Le/P, P♂, P♀, 17°06'24"S 145°36'52"E, Mt Haig, ?U. Emerald Ck, 17/18.xii.1997; Pe,17°16'S 146°55'E, Junction Ck, 1-4.iv.1997; 5L, 6Pe, Pe/♂, 17°26'48"S 145°28'28"E, Nigger Ck, 19.xii.1997; 4Pe, P♀,17°35'S 146°42'E, Palmerston NP, Learmouth Ck, 8/9.iv.1997; L, 17°37'S 145°45'E, Palmerston NP, Tchooratippa Ck, 8-9.iv.1997; Pe, 18°11.7'S 145°46.0'E, Yuccabine Ck, 9.vi.1997 (McKie); Pe, 18°20'S 146°03"E, Cardwell, 5-mile Ck, 1-4.iv.1997; Le/Pe/♀, Pe/♀, 18°58'S 146°09'E, Paluma, Birthday Ck, 24.x.1998 (McKie); Pe, 20°02'S 148°35', Eugella NP, Mt Dalrymple trail, ? Cattle Ck, 950m, 22.iii.1998; 1L, 6Pe, 20°21'20"S 148°43'15"E, nr Proserpine, Brandy Ck, 21-23.iii.1998; Pe, 25°03'S 153°03'E, Fraser I., Boomanjin L., 23/4.ix.1989; Le/Pe/♀, 27°06'S 152°27'E, Atkinson's Dam, 24/5.vii.1991 (Cook, Cranston & Hillman); 4L, L(P), 27°45'S 150°14'E, Tamborine Mt., Sandy Ck, 26.ix.1989. NSW: L, 3Pe, 30°16'S 152°50'E, nr Dorrigo, Eve Ck, 9.x.1996; Pe, 3, Pe/♀, ♂, 36°36'S 149°47'E, Brown Mt, Rutherford Ck, 17.xii.1990; Pe, 35°23'S 149°55'E, Monga SF, Mongarlowe R, 2.ii.1991. ACT: Brindabellas, 2Pe, 35°20'S 148°56'E, Pierce's Ck, 24.x.1991 (Drayson); 2L, 35°21'S 148°52'E, Warks Ck, 26.iv.1988 (Calder); Le/Pe/♂, 35°22'S 148°50'E, Pe, Blundell's Ck, 14.i.1988, L, 26.iii.1988, L, 6-9.iv.1988, 2L, 13-16.iv.1988, ♂, i-ii.1988 (Colless); Le/P♂, 2L(P), 35°22'S 148°51'E, Condor Ck, 27.x.1991; L, 35°28'S 148°21'E, Tidbinbilla, Cascade Ck, 3.ii.1989. VIC: Pe, Le/Pe/♀, ♂, 36°48'S 146°51'E, Buckland R., 6.v.1991 (Cook, Cranston & Nielsen); L, P♂, 36°54'S 147°27'E, Omeo Hwy, Omeo R, 26.i.1989; L(P), 36°58'S 147°54'E, Tambo R., Currawong Ck., 11.xii.1990 (Hortle); 8L, 37°08'S 147°51'E, Tambo R., Bindi Ck, 13.iii.1989 (Hortle). TAS: 2L, 41°09'S 148°07'E, NE Tasmania, Peters Link Rd, 24.ii.1993. WA: Le/P, 34°25'S 115°47'E, Carey Brook, 23.xi.1994.

DESCRIPTION. MALE. (n=3-4) Total length 3.5mm, wing length 2.5mm.

Colour. Head pale; antennal pedicel mid-brown, plume brownish; clypeus and palps pale. Ground colour of thorax mid-yellow, median and lateral vittae brown especially at anteriorly and laterally, anterior 1/3 of pre-episternum, scutellum and mid-postnotum. Legs pale with brown ring apices of mid and hind femorae, all tibae, and tarsomere1. Wings unmarked. Abdomen uniformly yellow, hypopygium golden-brown.

Head. AR c. 1.8, terminal flagellomere conical, 3 × as long as broad, penultimate flagellomere 8 × terminal flagellomere. Eyes with dorsomedial extension 5 ommatidia until expanding to 6 at mesal end. Temporal setae 16-18, comprised of 4 postorbital continuous with linear verticals. Clypeal setae 15-21. Palp well developed, each segment longer than preceding, 3rd segment with tight cluster of 3-4 sensilla clavata located on mesal surface just distal to mid-length of segment. Scape bare, pedicel with 6-8 ventral and 2 lateral setae.

Thorax. Scutal tubercle small, distinct. Antepronotal setae 2-4; acrostichals 31-36, biserial between the vittae, diverging around scutal tubercle and ending in prescutellar field; dorsocentrals 13-22, arising anteriorly in humeral field, uniserial between vittae, becoming irregular in prescutellar field; supraalars 1-2; prealars 8-10; scutellars 16-26. Preepisternum bare.

Wing. Costa bearing uniserial row of some 100 spines of length 8-10 (Fig. 5A), running for 25-30% of anterior margin from subapex. Costa extending c. 100 beyond apex of R_{4+5}, ending subapically, directly above M_{1+2}; R_{2+3} strong, running midway between R_1 and R_{4+5}; R_3 strong until abruptly terminating short of costa, closer to apex of R_1 than R_{4+5}. MCu slightly proximal to FCu, VR 0.86-0.90. Membrane densely setose except in radial cells, unpatterned. Anal lobe rounded. Squamal setae 24-27.

Legs. LR_1 0.52-0.56, LR_2 0.64, LR_3 0.78; all legs quite strongly setose, with beard ratio on all legs maximally 5, lacking any tarsal brush on tarsomere 3 of mid legs. Tibial spurs as in Fig. 5B, lengths: P_1 25-35, P_2 35-45, 80-90, P_3 35-45, 90-105; tibial comb of P_3 with 6 subequal setae.

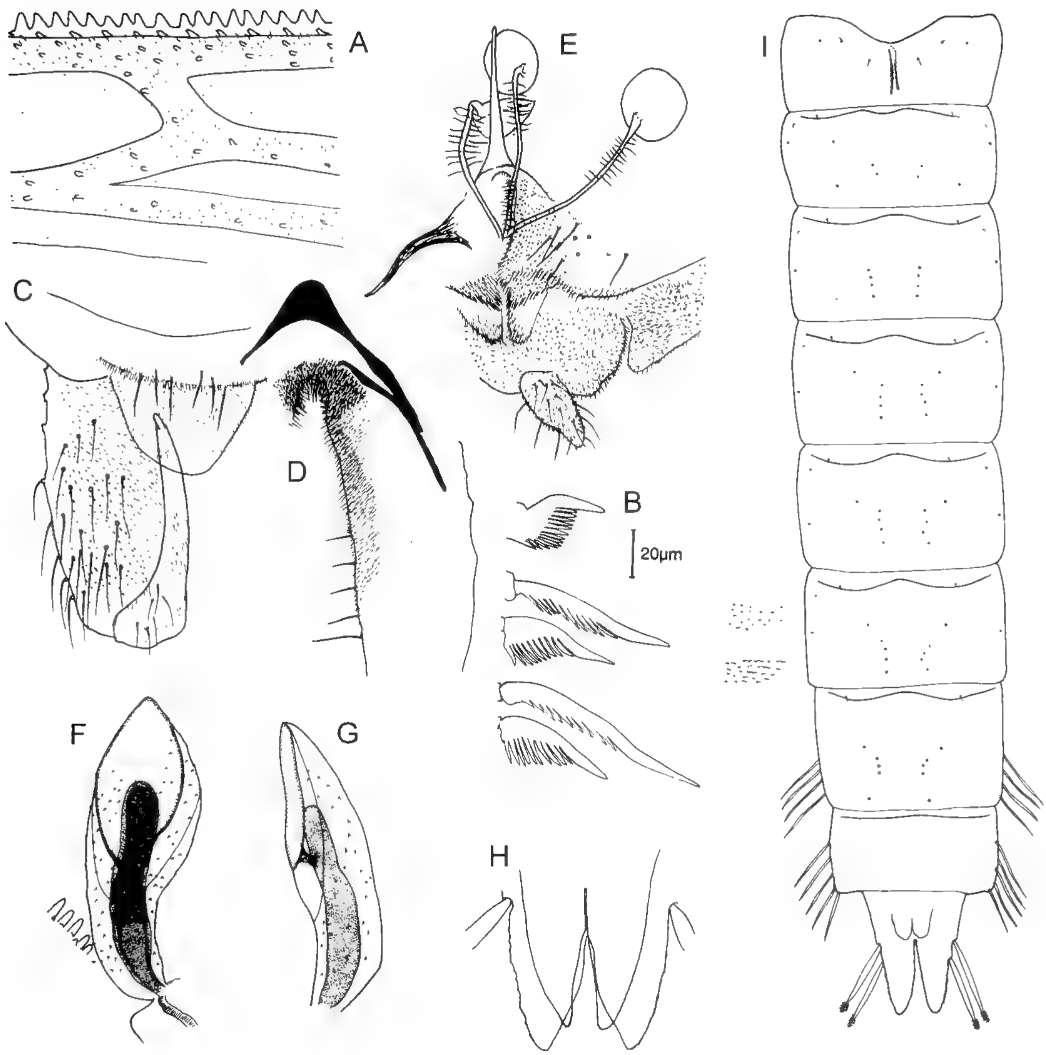

FIG. 5. *Australopelopia prionoptera* sp. nov., adult and pupa; A, anterior wing margin; B, spurs P_1, P_2, P_3.; C, ♂ genitalia, left side dorsal; D, right side showing base of gonostyli and volsella; E, ♀ genitalia, right side external, left side part internal; F-I, pupa: F-G, thoracic horn, F, dorsal, G, lateral; H, apex of anal lobe; I, tergites.

Claws slender, slightly curved, distally pointed, simple. Pulvilli absent.

Hypopygium. Tergite IX with an irregular median patch of 6-8 setae; 'anal point' broad and rounded, densely microtrichiose, perhaps bare apically (Fig. 5C). Gonocoxite 2.5 × as long as broad, cylindrical, densely microtrichiose mediobasally, setose with finer sparser microtrichia distally; with distinct evidence of volsella, a strongly setose slightly elevated triangular lobe beneath extended anal point (Fig. 5D). Gonostylus well developed, swollen at base, tapering in apical 2/3, terminal spur long. Phallapodeme long, sternapodeme an inverted V-shape (Fig. 5D).

FEMALE. (n=3) As male in colour and non-dimorphic features. Total length 2.5mm, wing length 2.3-2.5mm. AR 0.17-0.21, terminal flagellomere 130-175μm long, terminating in nipple. Eyes with dorsomedial extension 5-6 ommatidia wide. Temporal setae 13-14, linear uniserial. Clypeal setae 19-24. Palp as male.

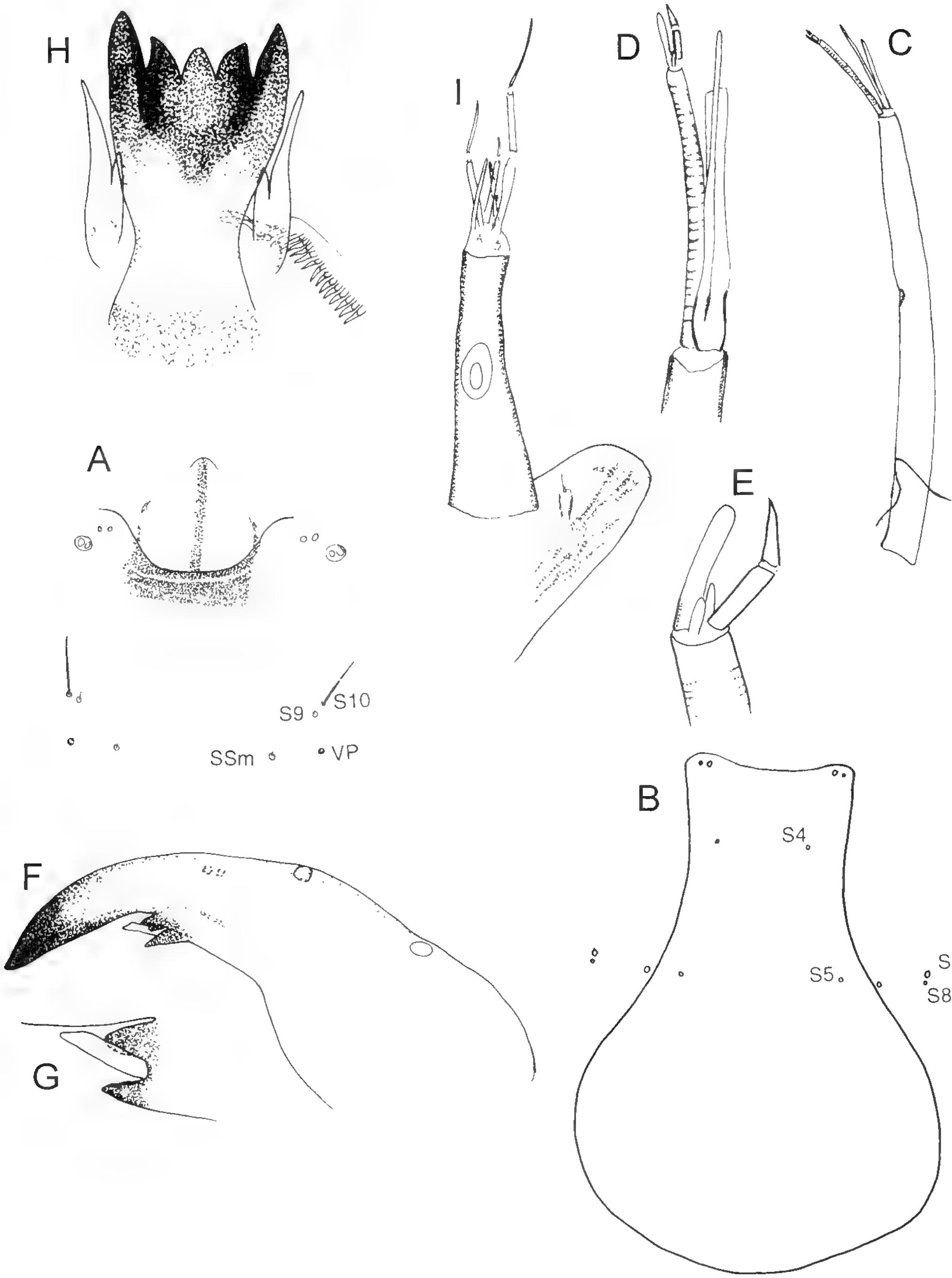

FIG. 6. *Australopelopia prionoptera* sp. nov., larva; A, mentum, submentum, ventral setae and pit; B, dorsal head, seate and dorsal pit; C, antenna; D, antennal segments 2-4; E, antennal apex; F, mandible; G, mola and seta subdentalis; H, ligula; I, maxilla.

Scape with 4 setae, pedicel with 9-13 setae forming semicircle. Antepronotal setae 3-7; acrostichals 32-38; dorsocentrals 24; supraalars 2-3; prealars 7-8; scutellars 20, biserial. LR_1 0.70, LR_2 0.66, LR_3 0.75; Tibial spur lengths: P_1 40-50, P_2 45-60, 60-80, P_3 40, 90-95.

Genitalia (Fig. 5E). Gonocoxapodeme VIII pale, gently curved, mesally broadened. Gonapophysis VIII triangular. Gonotergite IX without setae. Notum well developed, twice length of seminal capsule, free part of rami very pale. Tergite IX thin, non-setose. Postgenital plate large bearing small slightly pediform cerci. Three ovoid to globular seminal capsules, 70-85 long, spermathecal ducts microtrichiose, nearly straight, ending separately. Labia large, densely microtrichiose.

PUPA. (n=10) Length 4.5-5.3mm (tropical), 5.5-7.4mm (temperate), pale to golden yellow, apophyses brown, scar pale.

Cephalothorax. Thoracic horn (Fig. 5F) squashed cylindrical, narrower in lateral view (Fig. 5G), terminally tapered to broad point; 2.8-3.2 × as long as maximum width, external membrane with spines that may unite into meshwork. Hornsac tubular, occupying about half lumen at 1/3 from base, with squat connection to plastron at about 2/3 length from base. Plastron plate ovoid, occupying about 50% thoracic horn length, with narrow corona. Basal lobe modest tubercle c. 30μm long. Thoracic comb comprising 8-10 tubercles of length 25-35. Surface of thorax weakly granulate; scutal tubercle and postnotal tubercle absent. Single antepronotal seta retracted from margin, 1 weak precorneal seta; dorsal setae 1 and 2 present, simple, 2 displaced laterally to close to anterior wing sheath base, dcs4 taeniate, in supraalar position.

Abdomen (Fig. 5I). Tergite I with scar, lateral muscle marks very weak. Abdominal shagreen fine, aggregated on some segments to form rows. L setae taeniate only on segments VII (4, all clustered in posterior half) and segment VIII (all 5, more evenly spaced). D setae: 3 on I, 4 on II, 5 on III-VII, absent on VIII; $D_{2\text{-}5}$ arranged on segments III-VI in linear row. O-setae: 1 pair dorsal, 1 ventral, situated mid-curve of apophyses. Anal lobe (Fig. 5H) about 1.2 × as long as broad, bare, outer borders with spinules, inner border convex, outer border straight. Anal macrosetae at 0.5 × segment length. Gonopodial sheath of female short, of male extending c. 65% length of anal lobe.

LARVA. (n=10) Body length 5.4-6.5mm, head capsule length 640-890, golden-yellow with cephalic margin darker golden-brown to darker brown; mandible golden, tip brown, ligula golden brown basally, darker in distal half, anterior parapod claws fine and pale, posterior claws broader, simple, golden-yellow. Capsule longish-oval, cephalic index 0.7-0.75. Cephalic setation: SSm, V9 and V10 aligned at 45° to antero-ventral axis, VP posterior to V10 (Fig. 6A), dorsal pit present, S7 close to S8 (Fig. 6B).

Antenna (6C-E) half head length, segment lengths: 280-330: 65-70: 6-7: 5-6, AR: 3.6-3.7; basal segment c. 15 × as long as basal width, ring organ distal to mid-point (60%); second segment annulate (Fig. 6D). Blade bifid, broad outer branch slightly shorter than thin 75-80 inner branch. Lauterborn organs (peg sensilla, Sæther, 1980), small (c. 3); style c. 15 extending to apex of antenna.

Mandible (Fig. 6F) gently curved, with rather parallel-sided apical tooth, 130-165 long; long seta subdentalis arises between triangular accessory tooth and well developed, apically directed basal tooth, both protruding beyond inner contour of mandible (Fig. 6G). Ventrolateral setae closely approximated outer margin, separated from sensillum minusculum by same distance as posteriormost seta 3.

Ligula (Fig. 6H) with 5 teeth, row concave, with outer teeth and middle directed anteriorly, point of inner teeth strongly curved outward; ligula strongly constricted medially; area of muscle attachment ovo-rectangular, occupying basal 17-23%. Paraligula bifid, with outer branch near half length of ligula, 2× length of inner. Pecten hypopharyngis with 15-17 teeth, quite homogenous in size, slightly larger medially than laterally.

Maxillary palp (Fig. 6I) with strong ring organ situated in mid-segment, with well-developed crown of setae and sensilla including 3-segmented b-seta with each section subequal in length. Submentum with subapical transverse single band of lighter sclerotisation. Dorsomentum with minute traces of teeth; M appendage rounded-triangular, vesicles not distinguishable. Pseudoradula 8-11 wide, narrowed medially (i.e. slightly broader apically and basally), densely granulose without clear alignment, posteriorly without contact to any sclerotised area of ventral hypopharyngeal apodemes.

Abdomen. Body without a fringe of swim setae. Anal tubules slender, shorter than half length of posterior parapod, tapering apically, about 4× as long as basally wide. Procercus about 3× as long as wide (90-100 × 30-35), with 7 anal setae of length 450-500. Subbasal seta of posterior parapod simple. Posterior parapods with 15-16 simple short and triangular to long and narrow claws subtended by area of fine spinules on subapical parapod.

DISTRIBUTION, ECOLOGY AND BIOGEOGRAPHY. *Australopelopia prionoptera* is distributed on the eastern margin of Australia, from Cape Tribulation to northern Tasmania, predominantly in shaded streams. The single record in the Australian National Insect Collection from Western Australia is from the extreme southwest of the state from a shaded stream that harbours several other cool stenothermic taxa of gondwanan affinities. The larva, typically for the tribe Pentaneurini, is predatory with a diet that includes chironomid larva little smaller than its own length, and includes earlier instars of its own species.

As assessed by a year-long periodic interception of floating pupal exuviae, *A. prionoptera* adults, although few in number, emerged only in a narrow period of mid-summer in a southeastern subalpine stream (Willis, 1998). In contrast to the situation with *Echinocladius*, serendipitous 24 hr drift net collections suggest that this seasonality is artefactual. Final instar larvae can be found throughout winter, exuviae can be collected at almost any time of year, and larvae returned to the laboratory can pupate from within a few days to as much as several months later (Cranston pers. obs.; McKie pers. obs.). This phenomenon appears independent of feeding (usually a pupation stimulus to Tanypodinae larvae) or of temperature, and it may be that there is a partial, perhaps facultative diapause in this species.

When this taxon was thought to represent an Australian *Pentaneura*, this species was argued to represent a relictual gondwanan distribution, but the postulated phylogenetic position as sister group to a broad *Thienemannimyia*-group undermines the historical speculation. This group is almost world-wide, and its internal phylogenetic relationships are unknown: even some generic delimitation is suspect. Furthermore the Patagonian and New Zealand Tanypodinae are poorly known. However, the historico-ecological explanation of cool stenothermy mentioned under *Echinocladius* certainly appears to apply also to *Australopelopia*.

CHIRONOMINAE

Polypedilum Kieffer

Species of *Polypedilum* are found in virtually all aquatic habitats, and the genus is one of the largest (most speciose) in the world (Oyewo & Saether, 1998). The phylogeny is poorly understood, with first efforts by Oyewo & Sæther (1998) and Sæther & Sundal (1999) delimiting some clades, but leaving a morass of para/polyphyla, including some with subgeneric rank, notably *Pentapedilum* Kieffer. Many Australian taxa have been reared, keyed and illustrated (Cranston, 1996, 2000) but the continental biota is by no means completely understood. Amongst the fully reared taxa which are not associated with any previously described adult amongst the common species of *Polypedilum* from certain streams of the Wet Tropics. The species has been subject to experimental manipulation, and is described here to make the name available.

Polypedilum australotropicus sp. nov.
(Figs 7,8)

Polypedilum FNQ1, Cranston, 2000.

MATERIAL. HOLOTYPE Le/Pe/♂, 18°59'S 146°10'E, Queensland, Paluma, Birthday Ck, 800m, 1.x.1998, reared McKie, in ANIC. Holotype, and paratypes as follows: Queensland: 2Pe, 16°28'S 145°19'E, Mossman, nr Rex Ck, 5/6.iv.1997; 17°37'S 145°45'E, Palmerston NP, Tchooratippa Ck, 340m., 8-9.iv.1997; Pe, 17°47'.0 S 145°41'2E, Pixies Ck, 2/3.ix.1997 (McKie); Pe, 18°13'.1 S 145°48'5E, Goddard Bridge #1, 9/10.vi.1997 (McKie); Pe, 18°20'S 146°03"E, Cardwell, 5-mile Ck, 1-4.iv.1997; Pe, 18°58'.0S 146°09'8E, Camp Ck, 12/13.vi.1998 (McKie); Pe, 18°58'.7S 146°09'8 E, Mary Ck, 9.ix.1997 (McKie); Le/Pe/♀, 18°59'S 146°10'E, Paluma, Birthday Ck, 800m, 1.x.1998 (McKie); 12Pe, 25-26.iii.1998.

DESCRIPTION. Conforms in all morphology to the generic diagnoses for larva, pupa, and adult males (Wiederholm 1983, 1986, 1989) and females (Sæther 1977).

MALE. (n=1) Body length 2.7mm, pale with no darkening of vittae. Wing unmarked, length 1.2-1.3mm. Flagellomeres 1-12, 436, flagellomere 13, 375, AR 0.86. Frontal tubercles absent. Head with 9 verticals and postorbitals aligned, 11 clypeals, palp segment lengths 2-5, 35; 55; 74; 115. Thorax without antepronotals, with 9 acrostichals, 10 dorsocentrals, 3 prealars, 5 scutellars. Legs pale, unmarked, fore tarsomeres missing, mid-leg ratio 0.52, hind leg ratio 0.72; foretibial apex with rounded spur (Fig. 7A), mid-leg with narrow inner comb and broad outer comb with spur; hind leg with broad inner comb, narrower outer comb with long spur (Fig. 7B). Wing with R_{2+3} running close to R_1, evanescent; R_{4+5} gently curving, ending proximal to wing apex; setation: R 18, R_1 12, R_{4+5} 23, squama 5; venarum ratio 1.24.

Genitalia (Fig. 7C,D) with tergite IX bands faint, not meeting, 8 median dorsal tergal setae; posterior margin of tergite IX with 6-8 marginal setae. Anal point arising from posterior margin of tergite IX, hyaline, essentially parallel-sided to rounded apex, 35 long. Inferior volsella cylindrical, with few long setae and one strong apical seta, dorsally without microtrichia, ventrally densely microtrichiose. Superior volsella (Fig. 7D) with microtrichiose base and digitiform extension tapering to point, with outer strong seta at mid-point, where volsella contracts from broader base to digitiform apex. Gonocoxite 112; gonostylus 119, not tapered, apically rounded, without any mesal-directed setae.

FEMALE. (n=1) As for male in colour and non-dimorphic features. Body length 2.0mm, wing length 1.6mm. Flagellomeres 1-5, 105; 70; 80; 55; 145, AR 0.46. Head with 8-9 verticals and postorbitals aligned, 10 clypeals, palp segment lengths 2-5, 40; 70; 85; 150. Thorax without antepronotals, with 12 acrostichals, 12 dorsocentrals, 3 prealars, ? scutellars. LR: fore 2.27, mid 0.54, hind 0.76. Wing with R_{2+3} evanescent; R_{4+5} curving more strongly than in male, ending at wing apex; setation: R 17, R_1 16, R_{4+5} 31, squama 5; venarum ratio 1.21.

Genitalia typical for subgenus *Polypedilum*, with strong, curved gonocoxapodeme VIII, spherical seminal capsules (40-45μm diameter), without a neck, with nearly straight spermathecal ducts; with gonapophysis VIII divided into very small ventrolateral lobe, and larger dorsomesal lobe covered with linearly-aligned microtrichia (Fig. 7E).

PUPA. (n=10) Length 3.2-3.7mm, pale to mid-brown, with apophyses indistinct to brown pigmented.

Cephalothorax. Frontal tubercles absent, frontal seta 56-70. Thorax weakly creased, non-rugose. Thoracic horn (Fig. 7F) hyaline, base simple, small, circular; thoracic horn 3-4-branched, with one c. 220 long, weakly spinose branch.

Abdomen. Tergal armament as in Fig. 7G, tergite I antero-laterally with variably prominent antero-lateral projection, without sternal or tergal armament. Hook row comprising 36-51 hooks, extending 43-46% of the width of tergite II. Tergites II-VI with anterior transverse band of spines disconnected to any medial spines; II with few posterior spines, III-VI with sparse medial spine patch and essentially medially-divided posterior transverse band. Conjunctives III and IV with partially aligned multiserial rows of spines. Posterolateral corner of VIII (Fig. 7H) with small 'comb' of 3-4 basally-fused spines, one stronger than the others. Anal lobe bare, without dorsal seta, with uniserial fringe of 16-24 taeniae. Pedes spurii A on IV, weak on V, absent on VI. Pedes spurii B well-developed on II, absent on III. Taeniate lateral setae conventional for genus — 3,3,4,4 (V-VIII).

LARVA. (n=1-3) of unknown body length, head capsule length c. 420, very pale yellow, with teeth of mentum dark brown, apex of mandible and all teeth brown, occipital margin narrow, brown, labral margin golden-brown, premandible pale yellow.

Dorsal surface of head (Fig. 8A). Frontoclypeal apotome present, anteriorly broadened, bearing S3 seta subterminally inserted, posterior to 10-12 wide hyaline area, perhaps representing the clypeal relic. Antenna (Fig. 8C) with segment lengths, 33-37, 18-20, 9, 11, 6-7; AR 0.8; Lauterborn organs narrow, 10 long; blade length 47-50. Mandible (Fig. 8D): length 105-110, with short outer tooth, two inner teeth. Mola with two spines. Labrum (Fig. 8E); SI and SII setae finely plumose, pecten epipharyngis comprises three distinctly separated scales, each with 3-4 blunt teeth. Mentum (Fig. 8F); width 77-80, with rather bulbous protruding median teeth, small 1st laterals, tall 2nd laterals and remainder decreasing in size to clustered and somewhat projecting 5th and 6th, and small but distinct 7th. Ventromental plate with c. 40 striae, width 70-77, depth 26-30, medially with medially-directed pointed apex.

Abdomen. Anterior parapod claws pale golden, simple, dense. Procercus and apical setae pale-mid brown.

REMARKS. The larva of *P. australotropicus* belongs with a group of *Polypedilum* species with an uneven mentum, 3rd antennal segment slightly greater than half the length of 4th, ventromental plate width about 2.5 × the depth, and with the median (inner) contour of the plate medially directed, with only two inner

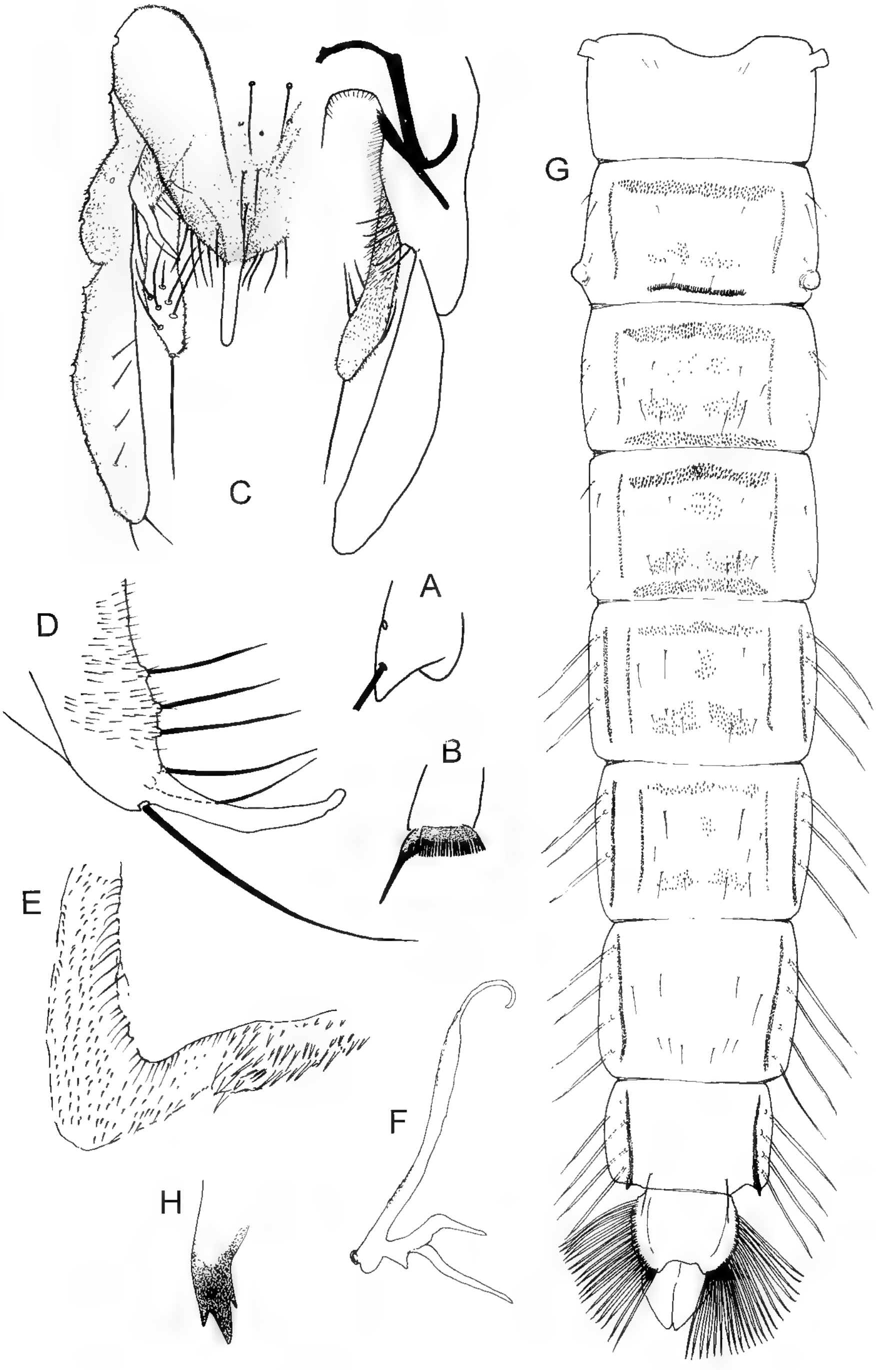

FIG. 7. *Polypedilum australotropicus* sp. nov. A-D, ♂; A, anterior tibial apex; B, posterior tibial apex; C, ♂ genitalia, left side dorsal, right side semi-internal; D, superior volsella. E, ♀, gonapophysis VIII: ventrolateral lobe, dorsomesal lobe. F-H, pupa; F, thoracic horn; G, tergites; H, posterolateral corner of VIII.

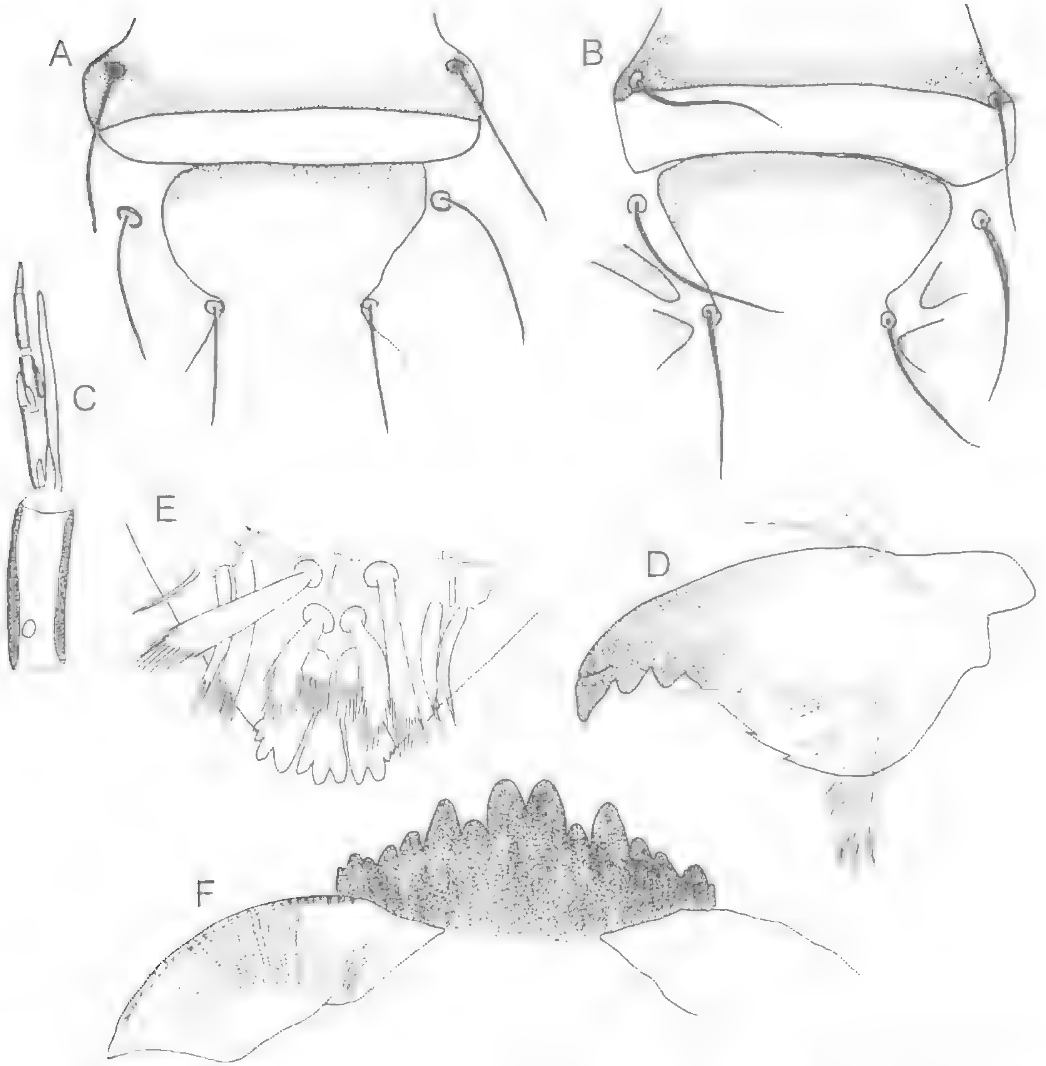

FIG. 8. *Polypedilum australotropicus* sp. nov., larva. A, anterior frontoclypeus; B, anterior frontoclypeus *Polypedilum* 'K3'; C, antenna; D, mandible; E, labrum; F, mentum and ventromental plate.

mandibular teeth and with the postoccipital margin dark. This group includes two taxa that have the median (inner) contour of the plate anteriorly directed — *P. oresitrophus* and 'M1', which are now placed in the subgenus *Uresipedilum* Oyewo & Sæther (1998). The two remaining Australian taxa with this combination of features but with the median ventromental plate contour medially-directed are undescribed and are referred to by the codes of 'K3' and 'alocasia' (Cranston, 1996, 2000). *P. seorsum* (Skuse), keyed as having a ventromental plate width: length ratio of 3 (versus 2.5) must be considered since these ratio can be as low as 2.6 and values actually overlap.

The larva of *P. australotropicus* is similar to that of *P.* 'alocasia', but the latter appears to differ significantly in ventromental plate features, with the approximately 20 striae having homogeneous width of 5μm at the anteromedian margin, in contrast to about 40 homogeneous striae of width 2μm in *P. australotropicus*. *Polypedilum* 'K3' has about 30 heterogeneous striae, with the outermost (laterad) 10 striae about 5μm wide, but with many narrower striae in the inner (mesal) half of the plate. A novel character that appears to allow separation is found on the dorsal surface of the head where the shape of the anterior frontoclypeal apotome, the breadth of the anterior hyaline band (perhaps representing the clypeus), and the position of cephalic seta S3 vary between species. In *P. australotropicus* and *P.* 'alocasia' the S3 seta is sited on a dilate anterior frontoclypeus separated from a narrow (10-12μm wide) hyaline area (Fig. 8A); expansion of the anterior frontoclypeus in 'K3' is weaker and the S3 seta is sited immediately posterior to a broader (20-25μm) hyaline section (Fig. 8B). In *P. seorsum* the hyaline anterior frontoclypeus is reduced to a very narrow strip of 2-4μm width. The elevation of the 6th lateral mental tooth with respect to the line of slope of the outer lateral teeth appears greater in *P. australotropicus* than in the other species, but interpretation of the feature is susceptible to preparation (orientation and compression) and wear.

The pupa of *P. australotropicus* belongs to a wider group that includes the two larval taxa noted above, defined by having only conjunctives III/IV and IV/V with multiserial spine bands, the anterior transverse spine band being separated from any median spine field, and having the weakly developed comb on the posterolateral corner of VIII includes a dominant spine and few subsidiary spines. The virtually bare median area of tergite II and lack of any armament on tergites VII and VIII differentiates from all species except *P. (Pentapedilum) convexum* which has a different comb comprising several subequal small spines. *P. seorsum* differs not least in the bare conjunctive III/IV. All prospective related species differ in having at least 4 lengthy non-spinose branches to the thoracic horn, unlike that of *P. australotropicus* which has a single dominant, spinose branch, and the others short.

The adult male of *P. australotropicus* has a hypopygium typical of many species of *Polypedilum* (in the strict sense, but not as represented by the type-species *P. nubifer*) with a narrow anal point and digitiform superior volsella with the microtrichiose basal section cylindrical, overlying a rounded contour of the gonocoxite with 5-6 strong setae. Similar species, including those with close resemblance in the immature stages differ as follows:

P. 'K3' has fore-tibial scale tapering to curved point, longer (46μm), narrower anal point, narrower cylindrical base and stouter digital part of the superior volsella, and a more tapered gonostylus.

P. 'alocasia' appears identical in hypopygium and foretibial scale structure, but differs in the male wing with R_{4+5} strongly curved and ending at the wing apex, and with denser thoracic setosity.

P. seorsum (Skuse) has a very similar hypopygium, although with a somewhat more evenly tapered digitiform part of the superior volsella, and weaker basal part, and differs principally in the triangular foretibial scale.

Too few species of *Polypedilum* are described as females to understand features that vary specifically. The small ventrolateral lobe of subgenus *Cerobregma* (Sæther & Sundal, 1999) also appears common in Australian members of *Polypedilum* (s.s.).

In summary, *P. australotropicus* appears to belong in a grouping of species appropriately placed in *Polypedilum* in the most restricted sense (i.e. the Holarctic-defined *P. nubeculosum* group), which includes several species in Australia, and more from southeast Asia (Cranston pers. obs.). In this group virtually all taxonomically useful features occur in every conceivable permutation, yet with the usually informative male genitalia being very homogenous. Phylogenetic analysis appears a Stygian task beyond the scope of this contribution.

DISTRIBUTION, ECOLOGY AND BIOGEOGRAPHY. *P. australotropicus* is narrowly restricted to cool streams at elevations from sea level to 800m in Far North Queensland's Wet Tropics, from Mossman to Paluma. Here the larvae can be quite abundant in leaf packs trapped in riffle-areas (B. McKie pers. comm.). The limited pupal exuvial evidence suggests continuous emergence.

ACKNOWLEDGEMENTS

Brendan McKie is acknowledged for his enthusiastic rearing of many specimens of several taxa during his studies in streams of the Brindabellas and the Wet Tropics, and for undertaking an exuvial survey of difficult-to-reach streams. Professors Nigel Stork and Richard Pearson of Cooperative Research Centre for Tropical Rainforest Ecology and Management (CRC Rainforest) sustained studies concerning the biodiversity of Chironomidae in the Queensland Wet Tropics. I thank all relevant authorities for collecting permits. My classically

trained colleague Robert Hoare assisted with nomenclatural matters.

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WABUA, A NEW SPIDER GENUS (ARANEAE: AMAUROBIOIDEA: KABABININAE) FROM NORTH QUEENSLAND, AUSTRALIA

VALERIE TODD DAVIES AND CHRISTINE LAMBKIN

Davies, V.T & Lambkin, C. 2000 12 31: *Wabua*, a new spider genus (Araneae: Amaurobioidea: Kababininae) from north Queensland, Australia. *Memoirs of the Queensland Museum* **46**(1): 129-147. Brisbane. ISSN 0079-8835.

Eleven new species of *Wabua* gen. nov. are described; these are *W. major*, the type species and *W. hypipamee*, *W. kirrama*, *W. seaview*, *W. elliot*, *W. eungella*, *W. crediton*, *W. aberdeen*, *W. cleveland*, *W. paluma* and *W. halifax*. All were collected between latitudes 17°16' and 21°13'S. A cladistic analysis shows that the Kababininae continues to form a well supported monophyletic group though its placement in a family remains problematical. ❒ *Araneae, Amaurobioidea, Kababininae, Wabua, taxonomy, distribution, Queensland, Australia.*

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This is the fourth genus to be described in the subfamily Kababininae: others are *Kababina* Davies 1995, *Carbinea* Davies 1999 and *Malarina* Davies 2000. The three described genera are all confined to the Wet Tropics region of northern Queensland which extends from Cooktown to Townsville. *Wabua* gen. nov. is also found in the Wet Tropics region (between latitudes 17°16' and 18°36'S) and, unlike the others, extends further south to Crediton (21°13'S), mid-east Queensland. For nomenclatural purposes Davies is designated the author of the names of the new genus and its species. All the species are named for their type locality. The female epigynum varies little between species whereas the male palp is complex and provides most of the characters for separation of species. The figures of epigyna and locality of specimens should aid identifications when using the key.

MATERIALS AND METHODS

Collection methods include litter-sieving followed by heat extraction in funnel, pitfall (PF) collection, pyrethrum (PY) spraying of tree trunks and fallen logs, hand collecting from under logs in daylight and night collecting. Notation of spines follows Platnick & Shadab (1975). All material is lodged in the Queensland Museum (QM). Cladistic methods are given under the section on relationships of *Wabua*.

Abbreviations. Most spiders were collected by G.B. Monteith (GBM) and fellow collectors D. Cook (DC), D. Yeates (DY), G. Thompson (GT), H. Janetzki (HJ) and S. Hamlet (SH); other collectors include R. Raven (RR) and V.E. Davies (VED). In location data: State Forest (SF), National Park (NP). S and E are given in the latitude/longitude data for the holotype only and omitted for the paratypes.

Anatomical abbreviations used in text, figures and in the list of characters and their states (Table 2): AL, abdomen length; ALE, anterior lateral eyes; ALS, anterior lateral spinnerets; AME, anterior median eyes; APOPH, apophysis; ATP, anterior tegular process; AW, abdomen width; CB, cymbium; CAL, calamistrum; CH, cheliceral; CL, carapace length; CR, cribellum; CW, carapace width; E, embolic; EG, epigastrial groove; EPIG, epigynal; ID, insemination duct; MAP, major ampullate spigots; MT, metatarsal; P, patellal; PCR, paracribellar spigots; PE, parembolic; PLD, prolaterodorsal; PLE, posterior lateral eyes; PLS, posterior lateral spinnerets; PME, posterior median eyes; PMS, posterior median spinnerets; RTA, retrolateral tibial apophysis; T, tarsal; TRICH trichobothria.

SYSTEMATICS

Subfamily KABABININAE Davies 1999

DIAGNOSIS. Medial atrium of epigynum wider than long; spermathecae posterior or lateral to atrium. Male palp with rounded tegulum with prolateral groove; course of sperm duct showing clearly. Membraneous conductor; median apophysis absent. Tibial apophysis with ventral and dorso-retrolateral branches.

DESCRIPTION. Carapace highest in foveal region; posterior eye row straight or slightly recurved; AME reduced. Chelicera with two retromarginal and two promarginal teeth; prolateral filamentous seta at base of fang longer than other setae. Feathery hairs on legs, ridged cuticle. Male palp: embolus with or without proximal embolic apophysis. Cribellum (two fields) present or absent in females, absent in males; large broad colulus present when cribellum is absent.

Wabua Davies gen. nov.

TYPE SPECIES. *Wabua major* sp. nov.

ETYMOLOGY. Derived from the Aboriginal 'wabu', meaning 'forest' in the Djirbal language of north Queensland.

DIAGNOSIS. Female cribellate (cf. *Carbinea*). Epigynum without posterior knob (cf. *Malarina*); with shallow medial atrium. Conductor and embolus of male palp arising antero-ventrally on tegulum (cf. *Kababina*); without proximal parembolic apophysis (cf. *Carbinea* and *Malarina*).

DESCRIPTION. Small spiders (most less than 4.0). Carapace pale with 2 dark longitudinal bands (see *Malarina* Davies & Lambkin, 2000: fig. 1A) sometimes reduced to dark lines radiating from fovea. Abdomen with a pattern of paired spots giving way to light median chevrons on dark ground (see *Kababina*, Davies, 1995: fig. 1D). Legs banded with darker rings. Conductor with stalk broadening to saucer shape with ragged edge. Embolus broad, narrowing distally.

KEY TO SPECIES OF *WABUA*

1. Posterior margin of epigynal atrium close to epigastrial furrow (Figs 1B, 2A). Leg I equal to or slightly longer than IV 2
   Posterior margin of epigynal atrium well forward of epigastrial furrow (Fig. 8F,K). Leg I shorter than IV . 10
2. RTA of male palp with distal and proximal projections (Fig. 1A,J). Distance between anterior margin of epigynal atrium and anterior loop of insemination duct less than length of atrium 3
   RTA without proximal projection. (Distance between anterior margin of atrium and anterior loop of insemination duct half - x2 length of atrium) 4
3. RTA with proximal bulge (Fig. 2C). Without mid-proventral protrusion of tegulum . . . . . . *major*
   RTA with large proximal spur (Figs 1J, 2D). With mid-ventral protrusion of tegulum (Fig. 1K) *hypipamee*
4. Distance between anterior margin of atrium and anterior loop of insemination duct x 1 or less length of atrium. (Male papal tibia with 2-4 retroventral setae, either discrete or forming a comb) 5
   Distance between anterior margin of atrium and anterior loop of insemination duct x 2 the length of atrium (Fig. 3G). Male palpal tibia with 3 long retroventral setae (Fig. 3J) . . . . *seaview*
5. Tibia of male palp with 4 long retroventral setae forming a comb (Fig. 6A) 6
   Tibia of male palp with 2-3 discrete retroventral setae (Fig. 4A) 8
6. Embolus with smooth curve from origin to prolateral edge (Fig. 4J) . . . . *eungella*
   Embolus widening at prolateral turn (Fig. 6A) 7
7. Embolic apophysis with 2 pointed 'folds' subdistal to embolus (Figs 6A, 7D) . . . . *crediton*
   Embolic apophysis with 2 reduced blunt folds (Fig. 6J) . . . . *aberdeen*
8. Tibia of male palp about as long as wide. ATP absent. . 9
   Tibia of male palp much longer than wide. Tegulum with mid-proventral protrusion and digitiform ATP (Fig. 8A) . . . . *cleveland*
9. Embolus with proventral keel (Figs 4A, 5A). RTA pointed, digitiform . . . . *elliot*
   Embolus without proventral keel (Fig. 2E). RTA blunt . . . . *kirrama*
10. Embolus with large retrolateral keel and smaller prolateral keel distally (Fig. 8J); palpal tibia as long as wide . . . . *paluma*
    Embolus smooth with small distal keel (Figs 8O, 9D,E); palpal tibia slightly longer than wide . . . . . . *halifax*

Wabua major Davies sp. nov.
(Figs 1A-E, 2A-C, 10A; Table 1)

MATERIAL. HOLOTYPE: ♀, Majors Mtn, N Qld, 17°38'S, 145°32'E, litter, 14-20.iv.1978, VED, RR (QM S39203). PARATYPES: N Qld: ♂, same data (S39204); 6♂, ♀, same data (S39205); ♀, Majors Mtn, 7km SE Ravenshoe, 1100m, sieved litter, 4.v.1983, GBM, DY (S39206); 4♀, Maalan SF, litter, 20.iv.1978, VED, RR (S39207); 2♀, Mt Father Clancy, Maalan SF, litter, 21 iv.1978, RR (S39208); ♂, Mt Father Clancy, 9km S Millaa Millaa, PF, 6-14.xii.1988, GBM, GT (S39209); 2♀, ♂, Downey Ck, 25km SE Millaa Millaa, 17°39', 145°47', sieved litter, 400m, 7.xii.1988, GBM, GT (S39210); ♀, ♂, Palmerston NP, E margin, 17°37', 145°46', 400m, PF, 2.xi.-10 xii.1995, GBM, DC (S39211); 4♂, same locality, 10.xii.1995-7.ii.1996 (S39212); ♀, 3 penult. ♂, Tully Falls Rd, 10km S Ravenshoe, 17°43', 145°31', sieved litter, 900m, 8.xii.1989, GBM, GT, HJ (S39213); ♂, Red Rd turnoff, Tully Falls Rd, 17°50', 145°32'; 750 m, PF, 8.xii.1989-5.i.1990, GBM, GT, HJ (S39214); ♂, 4♀, Upper Boulder Ck via Tully, 17°50', 145°54', 900m, sieved litter, 27.x.1983, GBM, DY, GT (S39216); 6♀, same data (S39217); 7♂, ♀, Upper Boulder Ck, 11km NNW Tully, 850-1000m, PF, 17-18.xi.1984, VED, GBM, J. Gallon, DC,GT (S39218); ♀, same data, 1000m (S39219); ♀, 1000m, sieved litter, 17.xi.1984, GBM, VED, GT (S39220); ♀, 18.xi.1984 (S39221); ♀, 1000m, PY on mossy rocks, 6.xii.1989, GBM, GT, HJ (S42111); ♀, Mt Tyson, 2km W Tully, 17°55', 145°54', 650m, sieved litter, 7.v.1983, DY (S42112); 3♀, ♂, Mt Fisher (Kjellberg Rd), 17°32', 145°33', 1100m, litter, 18.v.1995, GBM (S42117); 4♀, same data (S42118); 4♀, ♂, Tower nr The Crater, 17°27', 145°29', 1230m, litter, 23.xi.1994, GBM (S42119); ♀, Mt Fisher, 7km SW Millaa Millaa, 17°34', 145°34', 1050m, litter, 27.iv.1982, GBM,DY,DC (S42120); 4♀, 2 penult.♂, same data, 1100m, (S42121); 2 ♂, Millaa Millaa Lookout, 17°31', 145°34', 1000m, PF, 1.xii.1993-25.ii.1994, J. Hasenpusch (S42123); ♀, ♂, Sluice Ck, 9km WSW Millaa Millaa, 17°33', 145°33', 1150m, sieved litter, 5.xii.1988, GBM,GT (S42124); ♂, Massey Ck, 12km SW Millaa Millaa, 17°37', 145°33', 1000m, sieved litter, 4.v.1983, GBM, DY (S42125); ♂, 21km S Atherton, 17°27', 145°28', 1040-1100m , sieved litter, 5.xi.1983, DY, GT (S42126).

DIAGNOSIS. Epigynum with broad antero-lateral gonopores, insemination ducts narrowing to form anterior loop back to spermathecae. Short male palpal tibia, excavated ventro-retrolaterally with distal spur and proximal bulge. Two long proventral tibial setae extending half-way up tegulum.

DESCRIPTION. *Female*. CL 1.4, CW 1.0, AL 1.6, AW 1.1. Viewed from above the eye rows are straight; from the front anterior row is straight, posterior row is procurved. Ratio of AME: ALE: PME: PLE is 5:10:10:10. Legs 1423 (Table 1). Notation of spines. Femora: I, D110, P001; II, D110, P001, R001; III, D100, P001, R001; IV, D100, P001, R001. Patellae: I-IV, D001. Tibiae: I, V010; II, P001, V010; III, D001, P001, V011, R011; IV, D101, P001, V111, R101. Metatarsi: spined with distal whorl 4-5. Epigynum (Figs 1B-E, 2A): broad shallow atrium, anterior gonopores. Spermathecae lateral to atrium. Cribellum with 2 fields; ALS with 2 major ampullate spigots, posterior slightly smaller; about 15 piriform spigots. PMS with large anterior spigot (minor ampullate), a lateral and a posterior spigot (cylindricals), 4-5 paracribellar (one shaft per base) and some aciniform spigots. PLS with a large anterior spigot and 9 smaller spigots of 2 sizes. Females ranged in length from 2.9 -3.2.

Male. CL 1.7, CW 1.4, AL 1.8, AW 1.3. Ecribellate. Eyes similar to female. Legs 1=423 (Table 1). Notation of spines. Femora: I, D110, P002, R001; II, D110, P001, R001; III, D110, P001, R001; IV, D110, R001. Patellae: I, D001; II, D001; III, D101, IV, D101. Tibiae: I, P101, V021; II D101, P101, V010, R001; III, D010, P101, V111, R101; IV D101, P111, V112, R011. Metatarsi: spined with distal whorl 4-5. ♂ palp (Figs 1A, 2B,C): embolus curved sharply with flange-like apophysis. Short tibia, slightly longer than wide, 1:0.9; excavated ventrally with distal spur-like apophysis and proximal bulge. Spinnerets: ALS with one major ampullate spigot and a nubbin, about 14 piriform spigots, some tartipores. PMS with large anterior spigot (minor ampullate) and 7-8 spigots of two sizes. PLS with several spigots. Large colulus. Males varied in length from 3.1-3.5.

TABLE 1. Palp and leg measurements of ♀ (♂) *Wabua major* sp. nov.

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
Palp	0.7 (0.7)	0.2 (0.2)	0.5 (0.3)	- -	0.8 (0.8)	2.2(2.0)
Leg I	1.4 (1.7)	0.4 (0.5)	1.3 (1.8)	1.2 (1.7)	0.8 (1.0)	5.1 (6.7)
II	1.1 (1.5)	0.4 (0.5)	0.9 (1.3)	1.0 (1.3)	0.7 (0.7)	4.1 (5.3)
III	1.0 (1.4)	0.3 (0.5)	0.8 (1.1)	1.0 (1.2)	0.6 (0.7)	3.7 (4.9)
IV	1.3 (1.7)	0.4 (0.6)	1.2 (1.7)	1.3 (1.8)	0.7 (0.9)	4.9 (6.7)

DISTRIBUTION. (Fig. 10A) Widespread in rainforests from 400-1230m in the Hugh Nelson, Cardwell and Walter Hill Ranges to the immediate south and west of the Atherton Tableland.

Wabua hypipamee Davies sp. nov.
(Figs 1F-K, 2D, 10B)

MATERIAL. HOLOTYPE: ♀, Mt Hypipamee NP, N Qld, 17°26'S, 145°28'E, 950m, stick brushing, 5.x.1980, GBM (QM S42169). PARATYPES: N Qld: ♂, 3♀, same data as holotype (S42113); 2♂, Maalan Rd, 2km S Palmerston Highway, 17°36', 145°42', 750m, PF, 26.xi.1994-10.i.1995, GBM, J. Hasenpusch (S42114); ♂, same data, 10.i.-7.iii.1995 (S42115); ♂, same data, 7.iii.-15.v.1995, (S42116); 3♀, ♂, Millaa Millaa Falls, 17°28', 145°36', 800m, litter, 17.v.1995, GBM (S42122); ♂, 21km S Atherton, 17°27', 145°28', 1040-1100m, sieved litter, 5.xi.1983, DY, GT (S42127); ♀, same data (S42128).

DIAGNOSIS. Tegulum with mid-proventral protrusion (cf. *W. major*); male palpal tibia with large spur-like proximal apophysis (cf. *W. major*).

DESCRIPTION. *Female*. CL 1.4, CW 1.0, AL 1.6, AW 1.1. Ratio of AME: ALE: PME: PLE is 4: 9: 9: 9. Legs 1423, I 5.3; II 4.6; III 4.0; IV 5.2. Notation of spines similar to *W. major*. Epigynum (Fig. 1F-I) Spinnerets: similar to *W. major*. Females varied in length from 3.0-3.6.

Male. CL 1.6, CW 1.3, AL 1.6, AW 1.1. Colouration and eyes similar to *W. major*. Legs 1=423, I 6.7; II 5.2; III 4.9; IV 6.7. Male palp (Figs 1J-K, 2D): tegulum with a ventral protrusion supporting the conductor and embolus; tibia with anterior ventral and retrolateral apophyses and large proximal spur. Males varied in length from 2.9-3.2.

DISTRIBUTION. (Fig. 10B) From rainforests at 750-1100m in the Hugh Nelson Range and adjacent parts of the Atherton Tableland. This is the northernmost species of *Wabua*. It overlaps partly with the range of *W. major*.

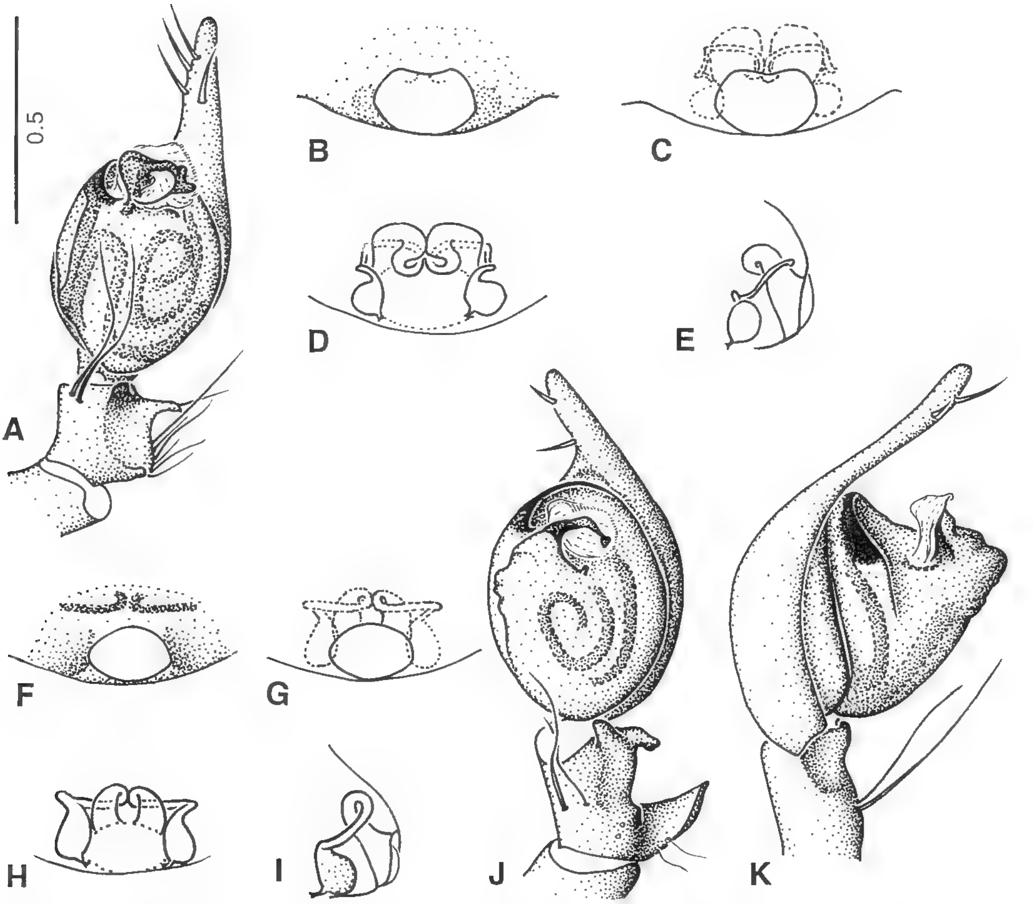

FIG. 1. A-E, *Wabua major* sp. nov; A, ♂ palp (ventral); B-E, ♀ epigynum (ventral, ventral cleared, dorsal, lateral). F-K, *Wabua hypipamee* sp. nov; F-I, ♀ epigynum (ventral, ventral cleared, dorsal, lateral); J, K, ♂ palp (ventral, prolateral).

Wabua kirrama Davies sp. nov.
(Figs 2E, 3A-E, 10B)

MATERIAL. HOLOTYPE: ♀, Kirrama Ra, Mt Smoko turnoff, N Qld, 18°12'S, 145°46'E, 600m, PF, 10.xii.1986-11.i.1987, GBM, GT, SH (QM S42172). PARATYPES: N Qld: ♀, ♂, same data as holotype (S42132); ♂ ♀, Kirrama Ra. (nr Yuccabine Ck) 18°10', 145°45', 700m, sieved litter, 10.xii.1986, GBM, GT (S42131); ♀, Boulder Ck, via Tully, 17°50', 145°54', 650m, sieved litter, 27.x.1983, GBM, DY, GT (S42170); 3 ♀, 2 ♂, same data (S39215); 2♂, Downey Ck Rd, Palmerston NP, 17°36', 145°46', PF, 25.vii.-30.iii. 1992, RR, P. & E. Lawless, M. Shaw (S24242); ♂, same locality, 30.x.1991-24.vii.1992, P. Lawless, RR, M. Shaw (S24592).

DIAGNOSIS. Embolus with small fluted flange subdistally; palpal tibia with small blunt distal RTA only (cf. *W. major* and *W. hypipamee*).

DESCRIPTION. *Female.* CL 1.4, CW 1.0, AL 1.5, AW 1.0. Colour and pattern similar to other species. Legs 1423, I 5.0; II 3.9; III 3.6; IV 4.8. Epigynum (Fig. 3B-E). Females varied in length from 2.9-3.1.

Male. CL 1.4, CW 1.1, AL 1.3, AW 1.1. Legs 1423, I 6.2; II 4.9; III 4.4; IV 6.1. Male palp (Figs 2E, 3A): very small inturned RTA. Males varied little in length 2.7-2.8.

DISTRIBUTION. (Fig. 10B) Occurs at 400-700m in rainforests of the Kirrama and Walter Hill Ranges. It occurs mostly to the south of the range of *W. major* but overlaps with it in the Walter Hill Range.

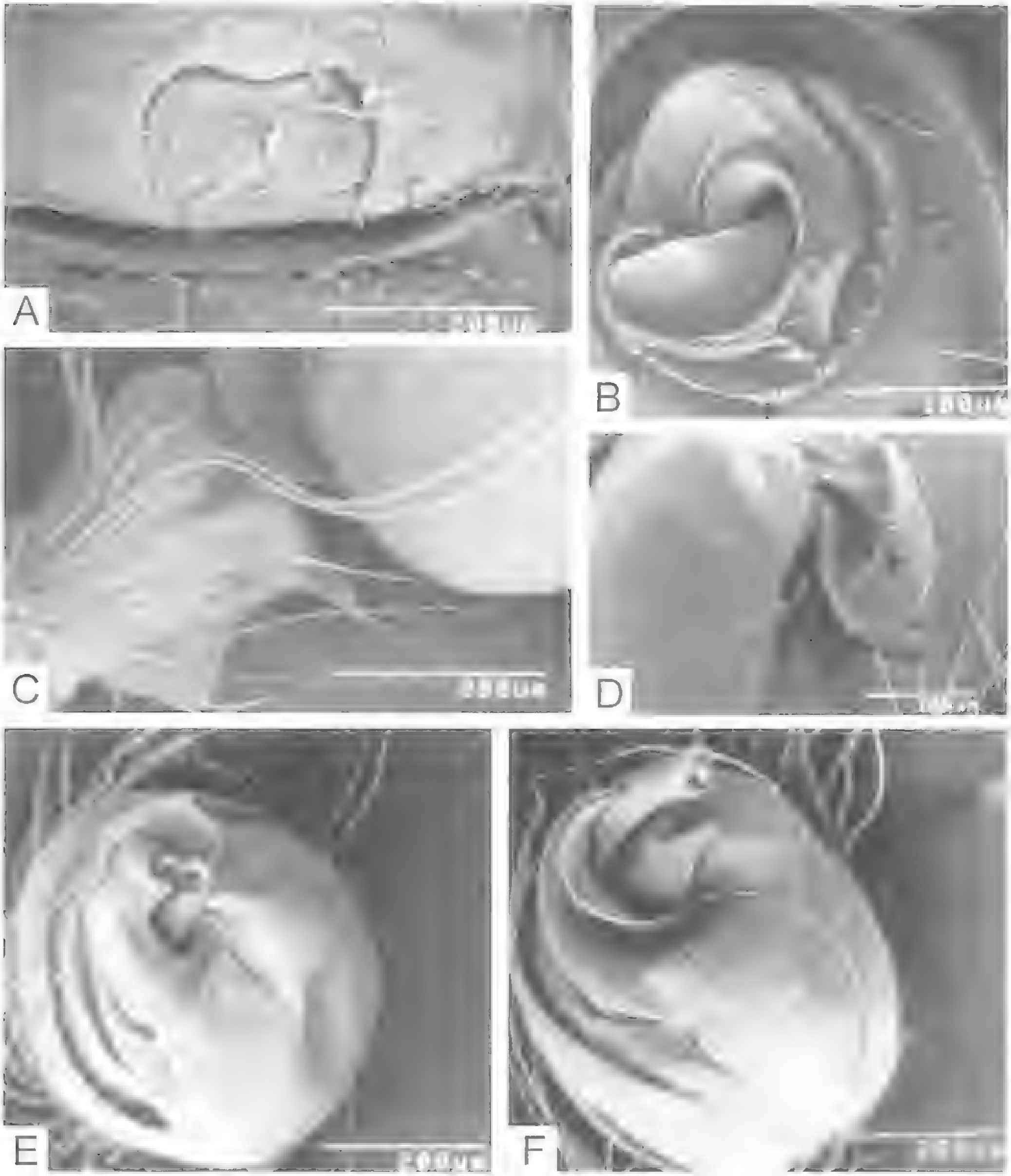

FIG. 2. A-C, *Wabua major* sp. nov.; A, epigynum (ventral); B,C, ♂ palp, B, embolic region, C. tibial apophysis. D, *Wabua hypipamee* sp. nov., protrusion of tegulum, embolus and conductor. E, *Wabua kirrama* sp. nov. (Boulder Ck) ♂ palp (ventral). F, *Wabua seaview* sp. nov. ♂ palp (ventral).

Wabua seaview Davies sp. nov.
(Figs 2F, 3F-K, 10B)

MATERIAL. HOLOTYPE: ♀, Seaview Range, Mt Fox Rd, N Qld, 18°38'S, 145°54'E, 600m, 15.xii.1986, GBM, GT, SH (QM S42171). PARATYPES: N Qld: ♀, 3♂, same data as holotype (S42133); 3♀, Mt Fox Rd, 18°50', 145°50', 600m, sieved litter, 15.xii.1986, GBM, GT (S42134); ♂,♀, same locality, 2.i.1987, SH (S42135); 3♂, ♀, Wallaman Falls Rd Junction, 18°39', 145°52', 650m, PF, 5-12.ii.1996, GBM (S42136); ♂, same data, flight intercept trap (S42139); ♀, Wallaman Falls Rd, 500m, PF,

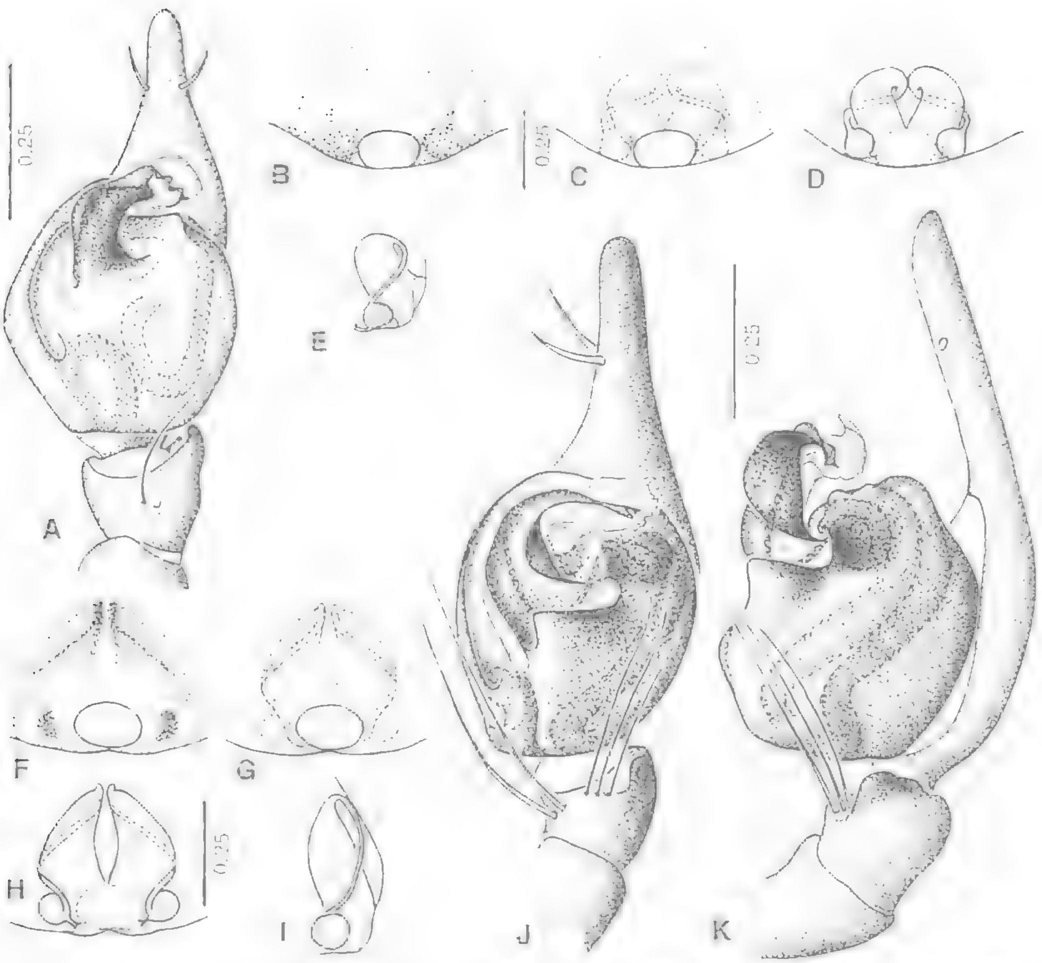

FIG. 3. A-E, *Wabua kirrama* sp. nov.; A, ♂ palp (ventral). B-E, epigynum (ventral, ventral cleared, dorsal, lateral). F-K, *Wabua seaview* sp. nov.: F-I, epigynum (ventral, ventral cleared, dorsal, lateral); J,K, ♂ palp (ventral, retrolateral).

14.xii.1986-2.i.1987, GBM, GT, SH (S42137); ♀, Wallaman Falls Rd, 18°38', 145°51', 650m, litter, 5.ii.1996, GBM (S42138).

DIAGNOSIS. The distance between the anterior margin of the atrium and the anterior loop of the insemination ducts is almost twice the length of the atrium (cf. *W. major* and other species). Keeled retrolateral edge of embolus; small blunt RTA. Palpal tibia with 3 discrete retrolateral setae.

DESCRIPTION. *Female*. CL 1.8, CW 1.4, AL 1.9, AW 1.4. Colouration and pattern similar to other species. Legs 1423, I 7.0; II 5.6; III 5.0; IV 6.9. Epigynum (Fig. 3F-I). Females varied in length from 3.3-3.8.

Male. CL 1.7, CW 1.4, AL 1.6, AW 1.3. Legs 1=423, I. 7.0; II 5.6; III 5,0; IV 7.0. ♂ palp (Figs 2F, 3J,K): retrolateral edge of embolus reflexed. Palpal tibia with 3 retroventral setae; RTA small, blunt. Males varied in length from 3.0-3.4.

DISTRIBUTION. (Fig. 10B) Restricted to the Seaview Range where it occurs in rainforests at 500-650m.

Wabua elliot Davies sp. nov.
(Figs 4A-E, 5A, 10B)

MATERIAL. HOLOTYPE: ♀, Mt Elliot summit, N Qld, 19°30'S, 146°57'E, 1150m, 26.iii.1991, GBM, DC (QM S17863). PARATYPES: N Qld: 2♂, ♀, same data as

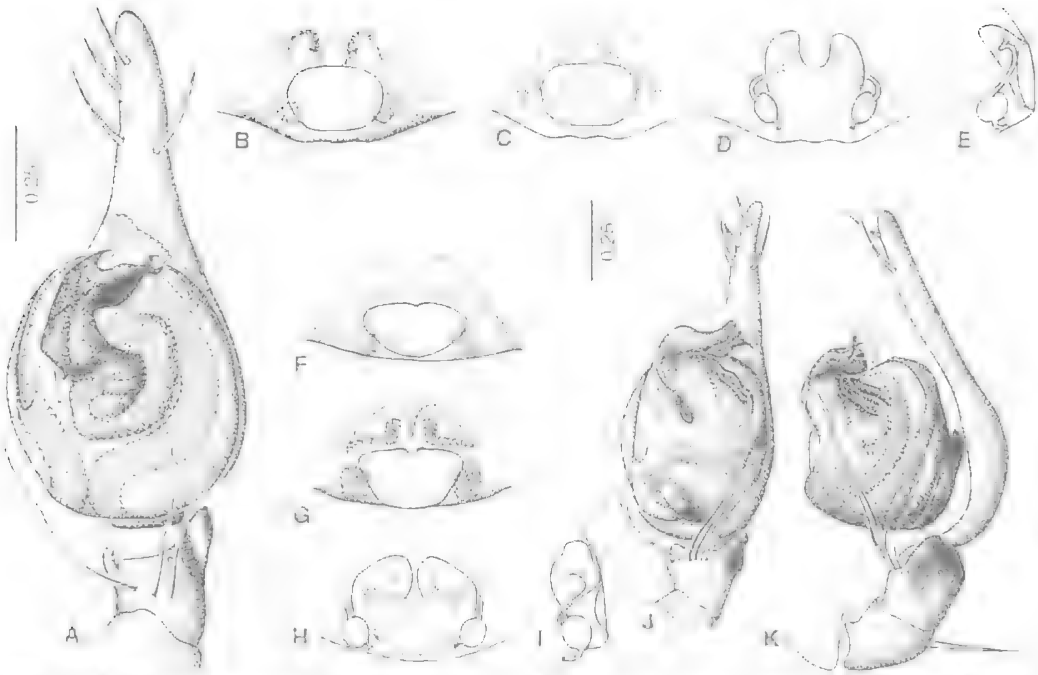

FIG. 4. A-E, *Wabua elliot* sp. nov.: A, ♂ palp (ventral); B-E, epigynum (ventral, ventral cleared, dorsal, lateral). F-K, *Wabua eungella* sp. nov.: F-I, epigynum (ventral, ventral cleared, dorsal, lateral); J,K, ♂ palp (ventral, retrolateral).

holotype, DC (S42145); ♀, Mt Elliot, North Ck, 19°29', 146°57', 1000m, 25.-27.iii.1991, GBM, DC (S42146); 2♂, ♀, same data (S17876); ♂, Mt Elliot summit, 1150m, PF and intercept traps, 26.iii.-12.v.1991, DC (S42147); ♂, same locality, PF, 1-26.iii.1991, A. Graham (S42165); 2♀, 5♂, Mt Elliot NP, Upper North Ck, 1000m, PF, 3-5.xii.1986, GBM, GT, SH (S42166).

DIAGNOSIS. Distance between the anterior margin of the atrium and the anterior loop of the insemination ducts is less than half the length of the atrium (cf. *W. seaview*). Long proventral keel on embolus; RTA pointed digitiform (cf. other species); 3 long discrete ventral setae on palpal tibia.

DESCRIPTION. *Female*. CL 1.5, CW 1.3, AL 1.8, AW 1.3. Carapace pattern of dark lines radiating from fovea; abdominal pattern similar to other species. Eyes, notation of leg spines similar to *W. major*. Legs 1423, I 7.1; II 5.7; III 5.1; IV 6.9. Epigynum (Fig. 4B-E): large atrium; distance between anterior loop of insemination duct and anterior margin of atrium is less than half length of atrium. Females varied in length from 3.2-3.8.

Male. CL 1.8, CW 1.4, AL 1.6, AW 1.1. Legs 1=423, I 8.2; II 6.7; III 6.1; IV 8.2. Male palp (Fig. 4A): proventral keel on embolus, tibia broader than long, 1:0.7, RTA pointed with edge incurved. Males varied in length between 3.2-3.8.

DISTRIBUTION. (Fig. 10B) Restricted to the rainforested summit (1000-1150m) of the isolated Mt Elliot, SW of Townsville.

Wabua eungella Davies sp. nov.
(Figs 4F-K, 5B-F, 10B)

MATERIAL. HOLOTYPE: ♀, Eungella (schoolhouse), mid-east Qld, 21°10'S, 148°24'E, rainforest, litter, 12.ii.1986, J. Gallon, RR (QM S42191). PARATYPES: mid-east Qld: ♂, 6♀, same data as holotype (S42155); ♂, same locality, PF, 11-14.ii.1986, J. Gallon, RR (S42192); 13♂, 2♀, same data (S42154); 4♀, same locality, under logs, rocks, 12.ii.1986, (S9915), 2♂, Dalrymple Rd, Eungella NP, 21°02', 148°36', PF, 9.xi.1991-29.vii.1992, P. Lawless, RR, M. Shaw (S24808); ♂, same data (S24811).

DIAGNOSIS. Epigynum with large atrium, anterior loop of insemination duct just above anterior margin of atrium (cf. *W. seaview*); tibia with 4 long retroventral setae forming comb (cf. *W. elliot*); without proventral keel on embolus.

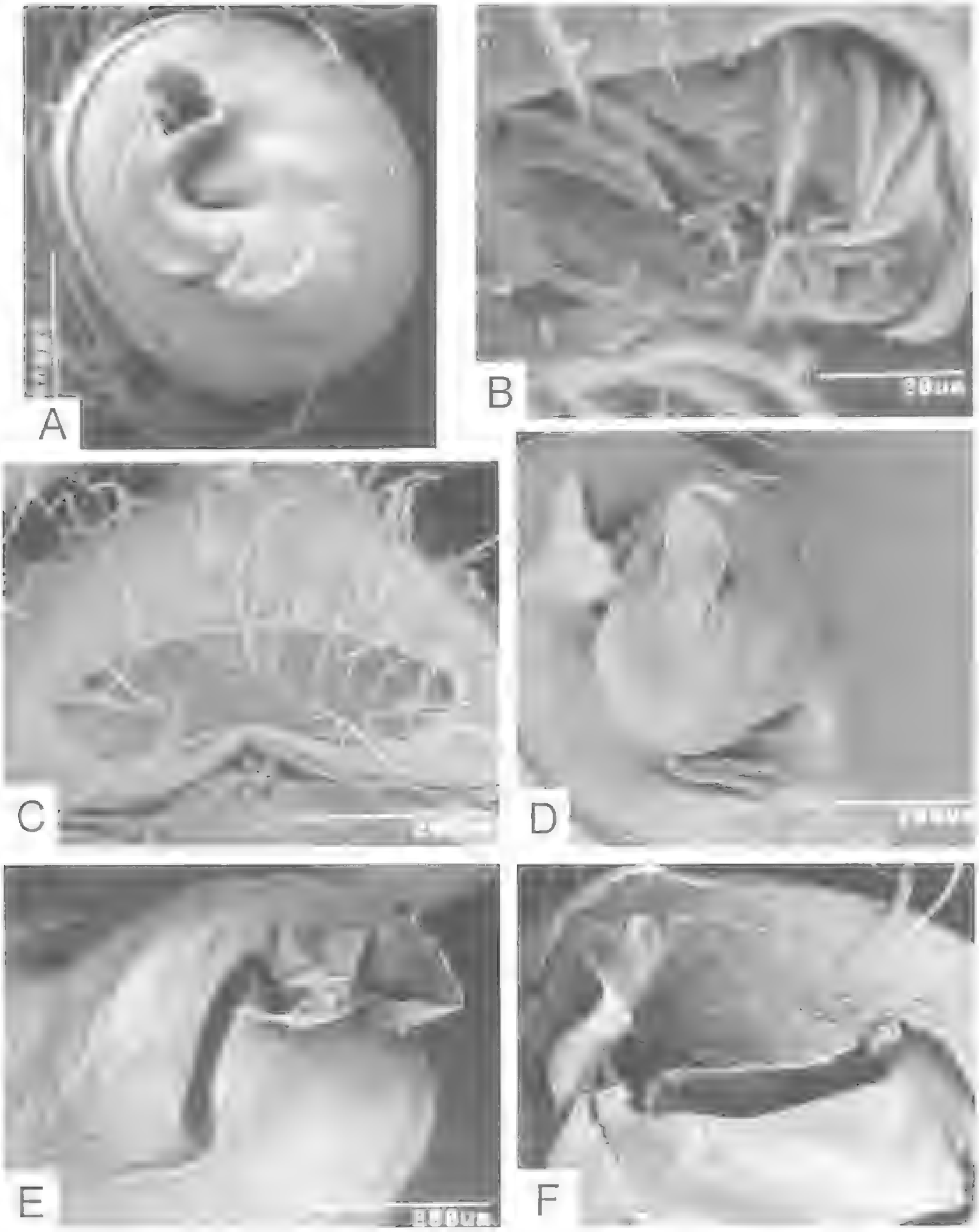

FIG. 5. A, *Wabua elliot* sp. nov., ♂ palp (ventral). B-F, *Wabua eungella* sp. nov.; B,C, ♀; B, ALS (l.), C, epigynum; D-F, ♂ palp, conductor/embolus (prolateral, retrolateral, ventral).

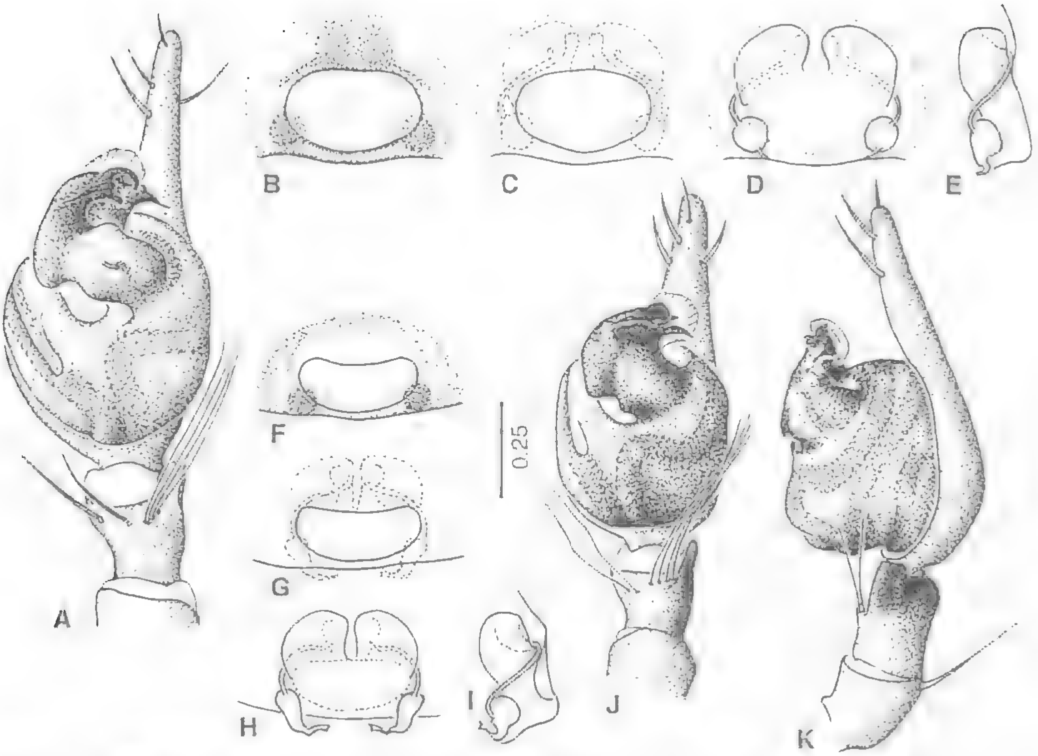

FIG. 6. A-E, *Wabua crediton* sp. nov.; A, ♂ palp (ventral); B-E, epigynum (ventral, ventral cleared, dorsal, lateral). F-K, *Wabua aberdeen* sp. nov.; F-I, epigynum (ventral, ventral cleared, dorsal, lateral); J, K, ♂ palp (ventral, retrolateral).

DESCRIPTION. *Female*. CL 1.9, CW 1.4, AL 2.0, AW 1.3. Legs 1423, I 8.1; II 6.4; III 5.8; IV 7.9. Epigynum (Figs 4F-I, 5C): broad atrium; loop of insemination duct close to anterior margin of atrium. Spinnerets: ALS with 2 major ampullate spigots, about 20 piriforms (Fig. 5B). PMS with large anterior spigot (minor ampullate), a large posterior and a large median spigot (cylindricals) 3-4 paracribellar spigots and some aciniform spigots. Short (10 setae) proximal calamistrum. Females varied in length from 3.3-3.9 in length.

Male. CL 1.9, CW 1.5, AL 2.0, AW 1.3. Legs 1423, I 8.3; II 6.5; III 2.0; IV 8.1. Male palp (Figs 4J,K, 5D-F): embolus with smooth curve from origin to prolateral edge; embolic apophysis with a larger (bulbous) and smaller fold, embolus pointed; tibia with 4 very long ventral setae forming a comb; RTA broad. Males varied in length from 3.4-3.9.

DISTRIBUTION. (Fig. 10B) Occurs in rainforests of the northern part of the Eungella portion of the Clarke Range, west of Mackay.

Wabua crediton Davies sp. nov.
(Figs 6A-E, 7A-D, 10A)

MATERIAL. HOLOTYPE: ♀, Crediton, mid-east Qld. 21°13'S, 148°34'E, 920m, litter, 14-21.iv.1975, R. Kohout, VED (QM S42195). PARATYPES: Mid-east Qld: 2♂, same data as holotype (S42157); 2♂, ♀, same data, with egg sac from webs in bases of dead palm fronds (S42156); 2♂, Broken R. Eungella NP, 21°10', 148°30', PF, 10.xi.1991-29.vii.1992, P. Lawless, RR, M. Shaw (S24815); ♂, same data (S24033).

DIAGNOSIS. The distance between the anterior margin of the atrium and the anterior loop of the insemination duct is x1 atrial length (cf. *W. seaview*). Male retroventral tibial setae forming comb (cf. *W. ellioti*). Curve of embolus with marked widening at prolateral edge (cf. *W. eungella*).

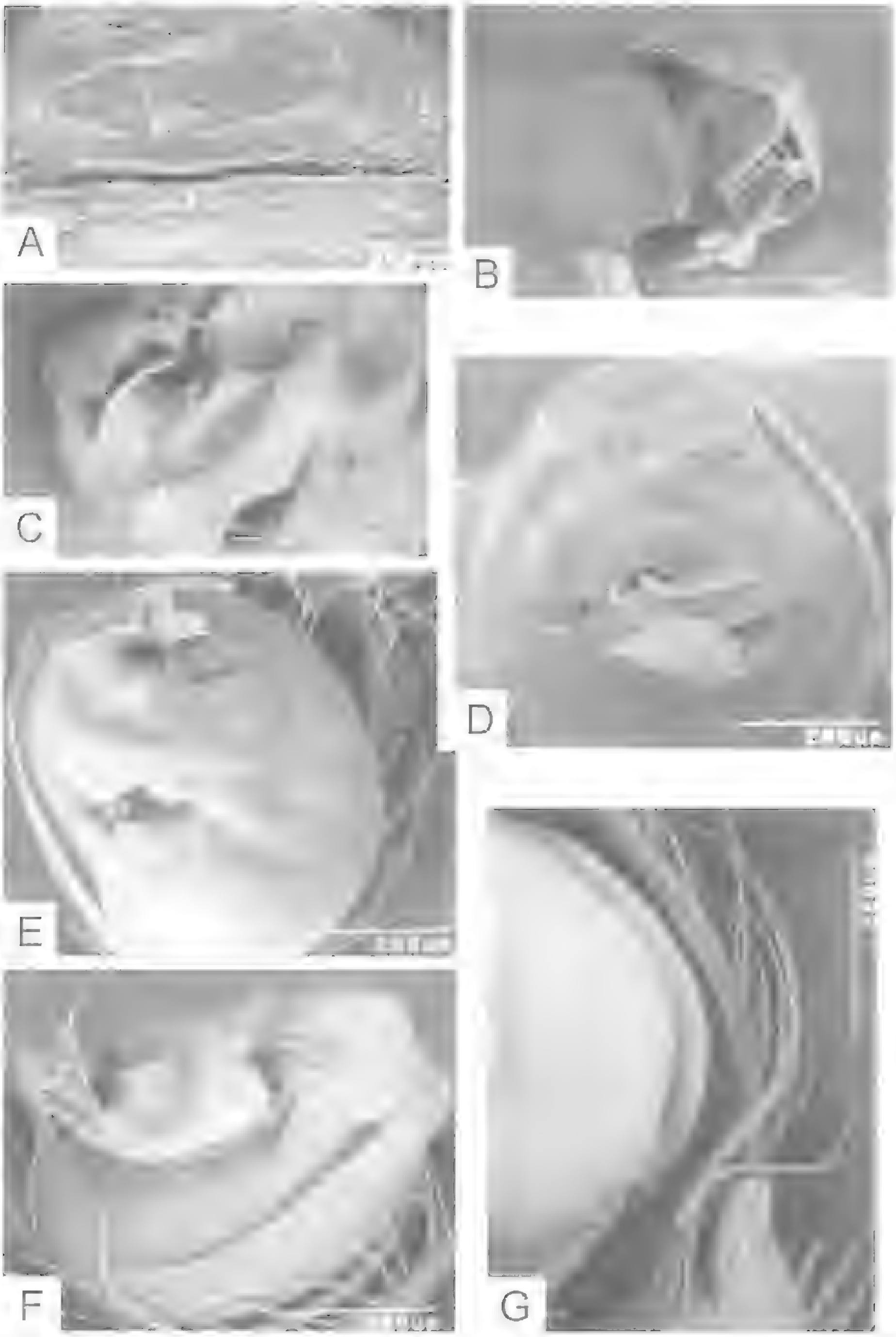

FIG. 7. A-D, *Wabua crediton* sp. nov.; A, epigynum; B-D, ♂ palp conductor/embolus, (antero-retrolateral, ventral, prolateral). E-G, *Wabua aberdeen* sp. nov.; E,F, ♂ palp (ventral, prolateral); G, RTA and comb of long setae.

DESCRIPTION. *Female.* CL 1.8, CW 1.3, AL 2.0, AW 1.2. Legs 1=423, I 6.9; II 5.5; III 5.1; IV 6.9. Epigynum (Figs 6B-E, 7A). Females varied in length from 3.8-3.9.

Males. CL 2.1, CW 1.7, AL 2.0, AW 1.4. Legs 1=423, I 8.7, II 7.1, III 6.5, IV 8.7. Male palp (Figs 6A, 7B-D). Embolus with marked widening of curve at prolateral edge (Figs 6A, 7C); embolic apophysis with 2 pointed 'folds' subdistal to embolus. Males were all longer than females, varying from 4.2-4.4.

DISTRIBUTION. (Fig. 10A) Occurs at the southern end of the Clarke Range and does not overlap with the range of the adjacent *W. eungella.*

Wabua aberdeen Davies sp. nov.
(Figs 6F-K, 7E-G, 10A)

MATERIAL. HOLOTYPE: ♀, Mt Aberdeen south summit, N Qld, 20°12'S, 147°53'E, 900m, 8.iv.1997, GBM, DC (QM S42150). PARATYPES: N Qld: 2 ♂, 2 ♀, Mt Aberdeen south summit, 20°12', 147°55', 900m, rainforest litter, 8.iv.1997, GBM (S42149); ♀, same locality, PY, 6.xii.1996, GBM, (S42151); ♀, Mt Aberdeen north summit, 850m, rainforest, 5-7.xii.1996, GBM, DC (S42152); 3 ♀, Mt Aberdeen south summit, 900m, 6.xii.1996, GBM, DC and I. Cook (S42153); ♂, Aberdeen summit saddle, 20°12', 147°53', 800m, PF, 5.xii.1996-8.iv.1997, GBM, DC (S42168); ♀, ♂, Mt Abbot summit shoulder, 20°06', 147°45', 1000m, open forest PF, 7.xii.1996-9.iv 1997, GBM, DC (S42148).

DIAGNOSIS. Distance between anterior margin of atrium and anterior loop of insemination duct less than half length of atrium (cf. *W. seaview*). Palpal tibia with 4 long setae forming comb (cf. *W. elliot*). Embolic curve with marked widening at prolateral edge (cf. *W. eungella*); embolic apophysis with 2 short-blunt folds subdistal to embolus (cf. *W. crediton*).

DESCRIPTION. *Female.* CL 1.8, CW 1.3, AL 2.0, AW 1.3. Legs 1423, I 6.8; II 5.4; III 5.0; IV 6.7. Epigynum (Fig. 6F-I): large atrium. Females varied in length from 3.0-3.8.

Male. CL 1.8, CW 1.4, AL 1.8, AW 1.2. Legs 1423, I 7.1; II 5.6; III 5.1; IV 7.0. Male palp (Figs 6J,K, 7E-G): prolateral keel on embolus; embolic apophysis with 2 short blunt folds subdistally; tibia with 4 long setae forming comb. Males varied in length from 3.6-3.8.

REMARKS. *W. eungella*, *W. crediton* and *W. aberdeen* appear to be closely related, differing only in embolic morphology.

DISTRIBUTION. (Fig. 10A) Restricted to the summits of the two isolated mountains, Abbot and Aberdeen, which lie to the west of Bowen in the arid corridor between rainforest of the Wet Tropics and mid-east Queensland (see O'Keefe & Monteith, this issue). On Aberdeen it occurs in rainforest but the Mt Abbot site is in wet sclerophyll.

Wabua cleveland Davies sp. nov.
(Figs 8A-E, 9A,B, 10A)

MATERIAL. HOLOTYPE: ♀, Mt Cleveland, N Qld, 19°16'S, 147°03'E, 100-300m, rainforest, 24.iii.1991, GBM, DC (QM S17923). PARATYPES: N Qld: ♂, same data as holotype (S42190); ♀, (S17883); ♂, Mt Cleveland summit, 560m, open forest, 22-24.iii.1991, GBM, DC (S42167); ♂, Killymoon Ck, 19°24', 147°01', S Townsville, PF, 26.x.1991-27.vii.1992, RR, P. Lawless, M. Shaw (S19945); ♂, nr Emmett Ck, S. Townsville, 19°27', 147°03', PF, 26.x.1991-27.vii.1992, P. Lawless, RR, M. Shaw (S19945); ♂, nr Emmet Ck, S Townsville, 19°27', 147°03', PF, 26.x.1991-27.vii.1992, P. Lawless, RR, M. Shaw (S21953). OTHER MATERIAL: ♂, Cape Upstart, N Qld, 19°44', 147°48', 4km N Station Hill, 550-650m, open forest 21-23.iv.1998, GBM (S42189).

DIAGNOSIS. Epigynal atrium wider than long 1:0.6. Distance between top of loop of insemination duct and anterior margin of atrium about a quarter length of atrium. Male palpal tibia longer than wide 1:0.4 (cf. all species). 3-4 very long discrete ventral setae on tibia. Anterior tegular process present (cf. all species). Male palpal femur much longer than cymbium, 1:0.7 (cf. other spp 1:1.1).

DESCRIPTION. *Female.* CL 1.6, CW 1.0, AL 1.9, AW (damaged). Ratio of AME: ALE: PME:PLE is 4:8:8:8. Carapace pattern of darker lines radiating from fovea; abdomen dark grey with pale paired spots. Legs 1=423, I 5.9; II 4.6; III 4.3; IV 5.9. Notation of spines very similar to *W. major.* Epigynum (Fig. 8B-E): large atrium; small distance between anterior rim of atrium and anterior loop of insemination duct, about a quarter length of atrium.

Male. CL 1.6, CW 1.3, AL 1.4, AW 0.9. Legs 1423, I 7.2; II 5.8; III 5.2; IV 7.1. Male palp (Figs 8A, 9A) a short sclerotised tegular process near embolus (Fig. 9B); tibia much longer than wide 1:0.4; forwardly directed RTA. Males varied little in length 2.8-2.9.

DISTRIBUTION. (Fig. 10A) Occurs in open forest and dry rainforest at several localities near the coast between Mt Cleveland at Cape Upstart. This is the only *Wabua* species which extends down to sea level.

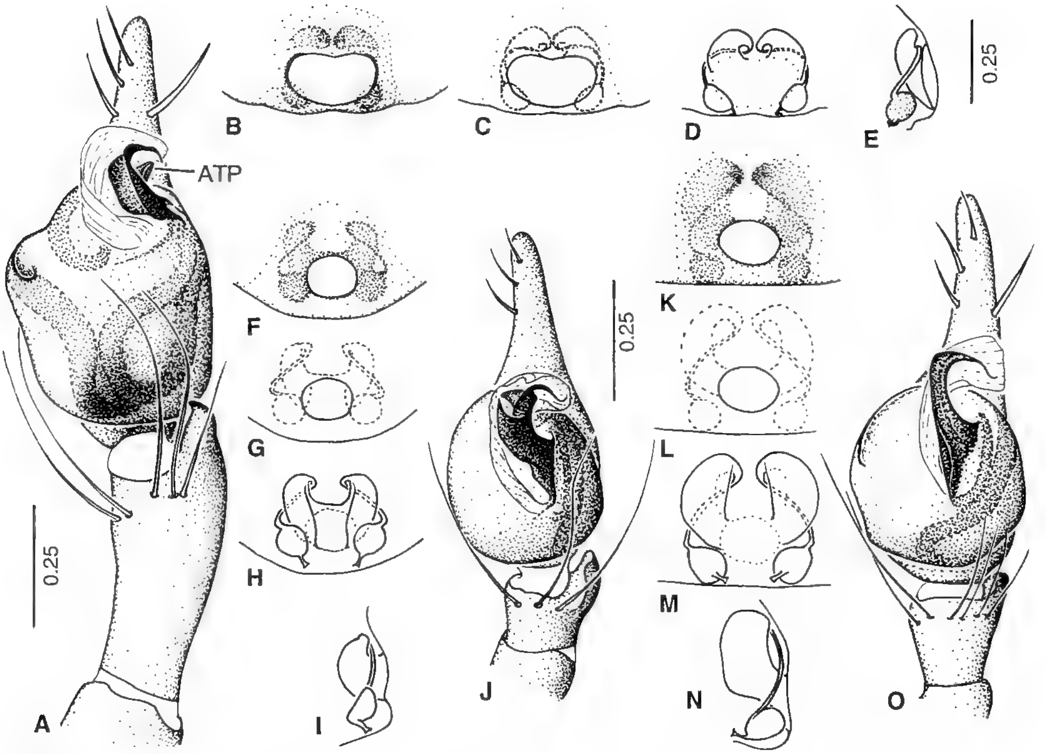

FIG. 8. A-E, *Wabua cleveland* sp. nov.; A, ♂ palp (ventral); B-E, epigynum (ventral, ventral cleared, dorsal, lateral). F-J, *Wabua paluma* sp. nov.; F-I, epigynum (ventral, ventral cleared, dorsal, lateral); J, ♂ palp (ventral). K-O, *Wabua halifax* sp. nov.; K-N, epigynum (ventral, cleared ventral, dorsal, lateral); O, ♂ palp (ventral).

Wabua paluma Davies sp. nov.
(Figs 8F-J, 9C, 10A)

MATERIAL. HOLOTYPE: ♀, Paluma Dam Rd, N Qld, 19°00'S, 146°19'E, 850m, site 5, PF, 8.xii.1990-5.ii.1991, GBM, J. Seymour (QM S42173). PARATYPES: N Qld: 2 ♂, same data as holotype (S42143); ♂, same locality, 800m, site 3, PF, 17.xi.-8.xii.1990, GBM, J. Seymour (S42140); ♂, 750m, site 4 (S42141); ♂, 720 m, site 2, flight intercept trap (S42142); ♂, 850m, site 5, PF (S42144).

DIAGNOSIS. Small spiders (<3.0). Epigynal atrium is small, almost as long as wide, situated well above the epigastrial groove (cf. all previously described species). Male palpal tibia is as wide as long (cf. *W. cleveland*) with 4 long discrete ventral setae; ventrally curved digitiform RTA.

DESCRIPTION. *Female*. CL 1.1, AL 0.9, AL 1.4, AW 0.9. Colour pattern similar to other species. Ratio of AME: ALE: PME: PLE is 4:8:8:8. Legs 4123, I 4.2; II 3.9; III 3.2; IV 4.4. Notation of spines similar to *W. major*. Short, proximal calamistrum. Epigynum (Fig. 8F-I): small atrium, well forward of epigastrial groove.

Male. CL 1.2, AL 1.0, AL 1.3, AW 0.9. Legs 4123, I 4.8, II 3.9; III 3.6; IV 4.9. Male palp (Figs 8J, 9C): embolic apophysis with a retrolateral keel and smaller distal prolateral keel. Tibia as wide as long with 4 long discrete ventral setae; RTA incurved ventrally and forwardly pointed. Males varied in length from 2.3-2.6.

DISTRIBUTION. (Fig. 10A) Restricted to rainforests at 700-850m at the northern end of the Paluma Range.

Wabua halifax Davies sp. nov.
(Figs 8K-O, 9D,E, 10B)

MATERIAL. HOLOTYPE: ♀, Mt Halifax summit, N Qld, 19°07'S, 146°23'E, 1050m, rainforest PF, 19-21.iii.1991, GBM, DC (QM S42193). PARATYPES: N Qld: ♀, ♂, same data as holotype (S42163); ♂, Mt Halifax, SE ridge, 950m, 19-21.iii.1991, GBM, DC (S42164); ♂, Mt Halifax summit, PF, heath, 19-21.iii.1991, GBM, DC (S17965), 3♂, Mt Halifax

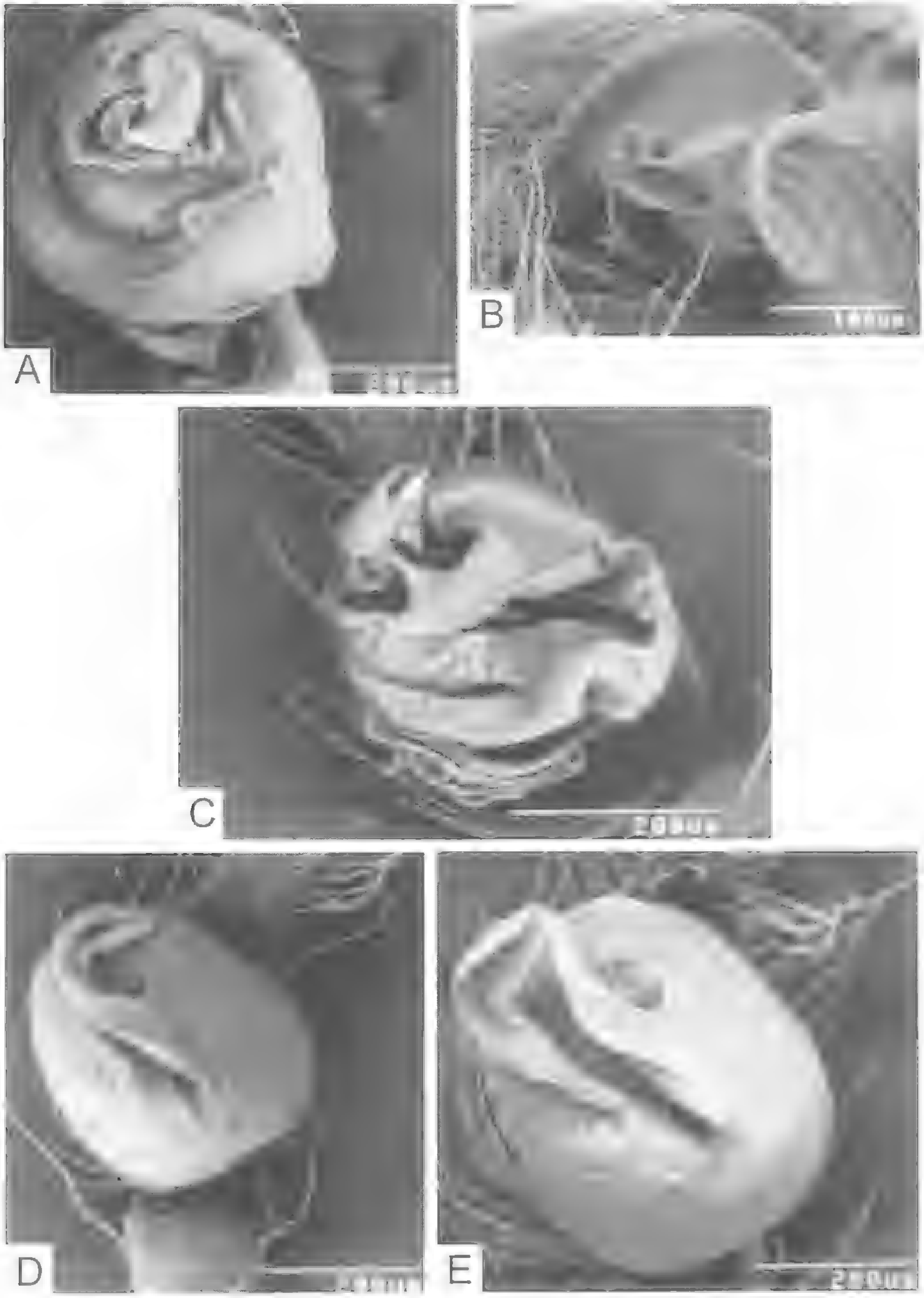

FIG. 9. A,B, *Wabua cleveland* sp. nov.; A, ♂ palp (ventral expanded); B, conductor/embolus and anterior tegular process (anterior). C, *Wabua paluma* sp. nov. ♂ palp (prolateral). D, E, *Wabua halifax* sp. nov., ♂ palp (ventral, prolatero-ventral).

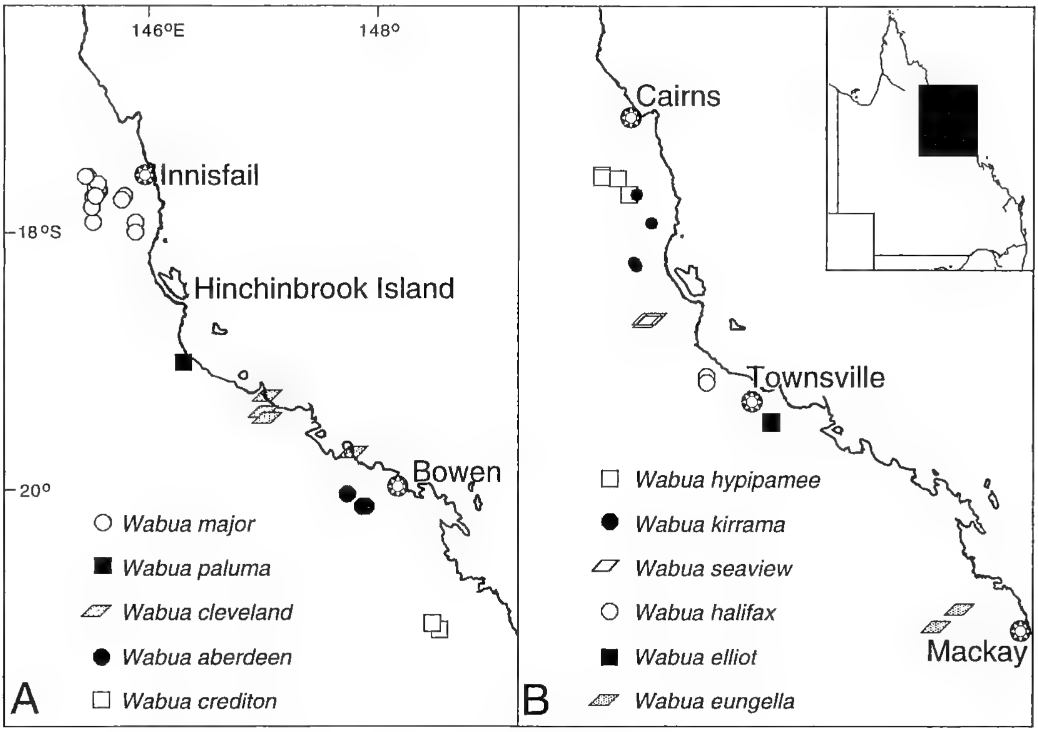

FIG. 10. Maps showing distribution of *Wabua* spp. in north Queensland.

summit, PF and intercepts, i.-20.iii.1991, A. Graham (S42160); ♂, Mt Halifax summit, open heath, 20.iii.1991, A. Graham (S42161); ♂, Mt Halifax, PF, xii.1990-8.i.1991, A. Graham (S42162); ♀, same data (S33733); 3♂, Bluewater Ra. 19°10', 146°23', 600m, sieved litter, 7.xii.1986, GBM, GT (S42158); ♀, (S42159); ♀, Bluewater Ra, 45km WNW Townsville, 6-700m, rainforest, 6-8.xii.1986, GBM, GT, SH (S42194).

DIAGNOSIS. Epigynal atrium small, situated well forward of the epigastrial groove (cf. all species except *W. paluma*). Embolus without large retroventral keel (cf. *W. paluma*), slight keel distally.

DESCRIPTION. *Female.* CL 1.5, CW 1.1, AL 1.6, AW 1.1. Ratio of AME:ALE:PME:PLE is 5:9:9:9. Legs 4123, I 6.6; II 5.2; III 4.8; IV 6.7. Notation of spines similar to *W. major.* Calamistrum with 12 setae. Epigynum (Fig. 8K-N): small atrium well forward of epigastrial groove. Females varied in length 2.6-3.3.

Male. CL 1.4, CW 1.1, AL 1.4, AW 0.8. Legs 4123,I 5.9; II 4.9; III 4.4; IV 6.3. Male palp (Figs 80, 9D,E): simple embolus with slight keel distally. Tibia slightly longer than wide 1:0.7. RTA small; four very long discrete ventral setae. Males varied in length from 2.6-3.6.

DISTRIBUTION. (Fig. 10B) Occurs in rainforest and adjacent heath at 600-1050m at the southern end of the Paluma Range. It does not overlap with the range of the adjacent *W. paluma.*

DISTRIBUTION

Wabua comprises a group of mostly allopatric species from the mountain rainforests of the southern half of the Wet Tropics region and the inland portion of the mid-eastern Queensland rainforest region. The only species that extends to the lowlands is *W. cleveland.* The greatest diversity is seen at the northern end of its range where three species (*W. hypipamee*, *W. major* and *W. kirrama*) partly overlap in ranges to the south and west of the Atherton Tableland. The genus is notably absent from the northern half of the Wet Tropics including the Carbine Tableland and the Bellenden Ker Range which are diverse for other invertebrate taxa (Monteith, 1995; Baehr, 1995). Comparing the range of *Wabua* with that of other kababinine genera (Fig.11) shows that on the

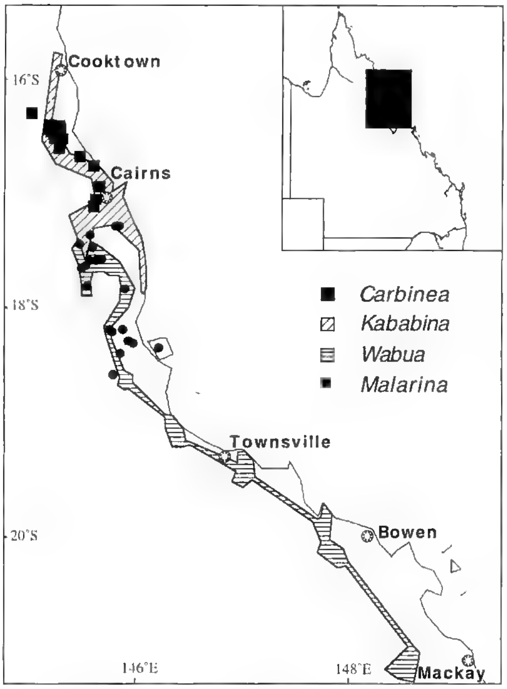

FIG.11. Map showing distribution of genera in the Kababininae in north Queensland.

Carbine Tableland *Wabua* may be replaced by *Kababina* or *Carbinea*, the only ecribellate genus. Nothing is known of the web of *Carbinea* but because it has no cribellum it may occupy a different microhabitat from *Kababina*. In the Bellenden Ker Range one species of both *Kababina* (*K. alta*) and *Malarina* (*M. masseyensis*) occur together at the northern limit of the latter. *Wabua* partly overlaps with *Malarina* on the Atherton Tableland mainly to the south and west while *Malarina* ranges eastward to the coast and Hinchinbrook Island.

RELATIONSHIPS OF *WABUA*

TERMINAL TAXA. A cladistic analysis examined 51 characters (Table 2) for relationships of the 11 *Wabua* spp. and 17 other taxa (Table 3). Outgroup comparison was with cosmopolitan *Oecobius navus* and an undescribed Australian dictynid.

Previous studies of the subfamily Kababininae have described the genera *Kababina* (Davies, 1995), *Carbinea* (Davies, 1999) and *Malarina* (Davies & Lambkin, 2000). Cladistic analysis including many taxa of the Amaurobioidea outlined the difficulty of family placement of the Kababininae. Inclusion of *Wabua* gen. nov., with a further 11 taxa, into the analysis caused loss of basal resolution when specific differences were scored. Considerable difficulties also arise in attempting to recognise primary homology across such a large and diverse group. Therefore the number of taxa outside the Kababininae has been reduced from 20 to 11, while maintaining sufficient exemplars to indicate placement within the Amaurobioidea. Type species for genera have been scored wherever possible.

DATA ANALYSIS. We analysed the data matrix of 51 characters for the 28 taxa (Table 3) using PAUP version 3.1.1 (Swofford, 1993) on a Power Macintosh 7100/66. Heuristic searches of the data were completed using 10 random step-wise addition sequences, tree-bisection-reconnection (TBR) branch swapping, MULPARS and branches having maximum length zero collapsed to yield polytomies. Semistrict consensus (Bremer, 1990) of the most parsimonious trees was computed using PAUP. Analyses were repeated using Hennig86 version 1.5 (Farris, 1988). The command mh* was used to find initial trees. The trees retained were then passed to the extended branch swapper, bb*.

The data matrix (Table 3) was prepared using MacClade version 3.01 (Maddison & Maddison, 1992) and PAUP version 3.1.1. Figure 12 was prepared using CLADOS version 1.2 (Nixon, 1992) with DELTRAN optimisation. Bremer support (Kallersjö et al., 1992) to indicate character support for nodes on the cladogram was calculated using the computer program Autodecay (Eriksson & Wikstrom, 1996).

RESULTS. Heuristic searches of 51 characters for the 28 taxa generated 4 most parsimonious trees of tree length 138, consistency index (Kluge & Farris, 1969) 0.62, consistency index excluding uninformative characters 0.58, retention index (Farris, 1989) 0.79 and rescaled consistency index (loc. cit.) 0.48. Figure 12 shows characters, character states and Bremer support values (above the nodes) on the preferred most parsimonious tree.

DISCUSSION

MISSING AND INAPPLICABLE DATA. Cladistic programs account for missing data by assigning states given the most parsimonious distribution of known characters. Missing data can a) contribute to the instability and poor resolution of cladograms (Novacek, 1992); and b) lead to the generation of different most

TABLE 2. Characters and character states.

1. AME: as large or larger than ALE (0); smaller (1)
2. CH: normal (0); small (1)
3. Retromarginal CH teeth: 2+ (0); 2 (1); 1 (2); 0 (3)
4. Promarginal CH teeth: 3+ (0); 3 (1); 2 (2); 0 (3)
5. Long prolateral seta at base of fang: absent (0); present (1)
6. Carapace: oval (0); round (1)
7. Foveal area highest: absent (0); present (1)
8. ♀ leg I: shorter than leg IV (0); equal to or longer than leg IV (1)
9. Stridulatory ridges on ♂ coxa I: absent (0); present (1)
10. Feathery hairs: absent (0); present (1)
11. MT preening comb: absent (0); present (1)
12. MT TRICH: 2+ (0); 1 (1)
13. T TRICH: 0 (0); 2+ (1); double row (2)
14. T rod: absent (0); present (1)
15. Anal tubercle: normal (0); enlarged (1)
16. PLS distal segment: normal (0); elongate (1)
17. CR spinning fields: 2 (0); 1 (1); absent (2)
18.* CAL: proximal (0); proximo-medial (1); long medial (2); no CAL (3)
19. MAP ♀ ALS: 2 (0); 1 and nubbin (1); 1 (2)
20. MAP ♀ ALS: mesal (0); anterior (1)
21. PCR ♀ PMS: one shaft per base (0); more than one shaft (1); absent (2); no CR (3)

Female characters

22.* EPIG gonopores: lateral (0); central (1); posterior (2); anterior (3)
23.* Medial EPIG atrium: absent (0); present (1)
24.* Posterior rim of medial atrium/EG: no medial atrium (0); close (1); well forward (2)
25.* Width/length medial atrium: no medial atrium (0); < 2x wider than long (1); 2-3x wider than long (2); > 3x wider than long (3)
26.* Loop in ID anterior to EPIG atrium : no atrium (0); atrium but anterior loop absent (1); present [2)
27. ID: simple (0); loosely coiled (1); tightly coiled (2)
28.* Posterior EPIG scape: no scape (0); small knob (1); short (2); long (3)
29. EPIG lateral teeth: absent (0); present (1)

Male characters

30.* E: long spiniform (0); short spiniform (1); short broad (2); long broad (3)
31.* Tegular origin of E: posteroventral (0); medial (1); anteroventral (2)
32. Width of medial section of E: uniform or decreasing (0); increasing at prolateral curve (1)
33. PE APOPH: absent (0); unbranched (1); branched (2)
34. E APOPH prolateral keel: absent (0); present (1)
35. E APOPH retrolateral keel: absent (0); present (1)
36. E APOPH plate-like setae: absent (0); present (1)
37. PLD setae E APOPH: absent (0); present (1)
38.* E APOPH 2 subdistal folds: absent (0); pointed (1); blunt, reduced (2)
39. Separate retrolateral anterior tegular sclerite: absent (0); present (1)
40. Anterior prolateral tegular extension: absent (0); present (1)
41.* Conductor: irregular (0); short rounded (1); large T-shaped (2); s-shaped - falciform (3); long rounded (4)
42. Median APOPH: absent (0); present (1)
43. Orientation of CB to bulb: dorsal (0); lateral (1)
44. RTA/CB length: absent (0); quarter or less (1); more than half (2)
45.* RTA proximal projection: no RTA (0); no proximal projection (1); blunt swelling (2); pointed spur (3)
46.* RTA dorsal branch : no RTA (0); branch absent (1); branch present (2)
47.* RTA extra distal branch: no RTA (0); extra branch absent (1); extra branch present (2)
48. Palpal tibia with very long ventral setae: absent (0); present (1)
49.* Retroventral palpal tibial setae: absent (0); discrete (1); comb (2)
50. Palp tibia length/width: shorter or long as wide (0); longer than wide (1)
51. Palpal P APOPH: absent (0); present (1)
[* Multistate characters treated as unordered]

parsimonious trees than when the actual values for the states are included (Nixon & Davis, 1991).

Platnick et al. (1991) showed that cladistic computer analysis of data matrices containing missing entries (missing or inapplicable data) may produce fully resolved cladograms that cannot be supported by any conceivable assignment of the possible states because of nodes supported by mutually exclusive optimisations of the same character, or optimisations at internal node of unobserved conditions. Wilkinson (1995) considered that some of these trees contained linked sets of interior branches that simultaneously have zero and non-zero lengths, a problem that current computer algorithms have difficulty dealing with. Hennig86 and PAUP version 3.1.1 report resolutions supported by potential optimisations, whether or not the optimisations supporting different branches are simultaneously possible. This can result in cladograms that are not supported by the matrix (Nixon & Wheeler, 1992).

While most systematists code inapplicables as missing data, Maddison (1993) suggested coding the inapplicable data as a new state in a multistate character. While this methodology is reliant on a questionable assessment of primary homology, it avoids the production of large numbers of unstable, unsupported or unresolved cladograms (Novacek, 1992); and more importantly nonsensical optimisations of unobserved conditions. For these reasons we coded inapplicables of *Oecobius* as separate pleisiomorphic states in multistate characters, thus avoiding the problems

TABLE 3. Data matrix.

Taxa	Character Number					
	10	20	30	40	50	
Oecobius navus Blackwall	0133010000	0100110120	2200000001	0000000000	0100000000	0
Dictynidae sp.	1020000100	0100001021	0100002000	0000000000	2011111000	0
Badumna longinqua (Koch)	0010000100	0010000000	1112210010	0000000000	3101111000	0
Paramatachia decorata Dalmas	0010000100	0010001200	0300000000	0000000000	3001111000	1
Desis sp.	1010000100	0020002321	3100002010	0000000000	3101111001	0
Amphinecta milina Forster & Wilton	1010000000	1010002310	3000001010	2000000000	1101111001	0
Amaurobius fenestralis (Stroem)	0000000100	1010000000	0000000012	2000000000	1101121000	0
Storenosoma terranea Davies	1012000010	1010002310	3200000012	2000000000	1101121000	0
Otira sp.	1012000010	1011002310	3200000002	2000000001	1101121000	0
Stiphidion facetum Simon	0011100101	0010000100	1200000000	0000000000	2001111000	0
Stiphidion adornatum Davies	0011100101	0010000100	1200002000	0000000000	2001111000	0
Kababina alta Davies	1012101101	0010000000	0112320000	1001000000	4002112110	0
Kababina covacevichae Davies	1012101101	0010000000	0112220000	1000000000	4002112110	0
Carbinea longiscapa Davies	1012101101	0010002300	3112210303	2020000000	4002111110	0
Carbinea breviscapa Davies	1012101101	0010002300	3112210203	2020000000	4001111110	0
Malarina monteithi Davies	1012101101	0010000000	0112210103	2010011000	4001111110	0
Malarina cardwell Davies	1012101101	0010000000	0112112103	2010011000	4001111110	0
Wabua major sp. nov.	1012101101	0010000000	0111121003	2000000000	4001211110	0
Wabua aberdeen sp. nov.	1012101101	0010000000	0111121003	2100000200	4001111120	0
Wabua cleveland sp. nov.	1012101101	0010000000	0111121003	2000000010	4001111111	0
Wabua crediton sp. nov.	1012101101	0010000000	0111121003	2100000100	4001111120	0
Wabua elliot sp. nov.	1012101101	0010000000	0111121003	2001000000	4001111110	0
Wabua eungella sp. nov.	1012101101	0010000000	0111121003	2000000100	4001111120	0
Wabua halifax sp. nov.	1012101001	0010000000	0112121003	2000000000	4001111110	0
Wabua hypipamee sp. nov.	1012101101	0010000000	0111121003	2000000000	4001311110	0
Wabua kirrama sp. nov.	1012101101	0010000000	0111121003	2000000100	4001111110	0
Wabua paluma sp. nov.	1012101001	0010000000	0112121003	2001100000	4001111110	0
Wabua seaview sp. nov.	1012101101	0010000000	0111121003	2000100000	4001111110	0

resulting from computerised cladistic analyses of missing data.

RELATIONSHIPS IN THE AMAUROBIOIDEA. *Oecobius* and Dictynidae sp. appear as distinct from the ingroup which is regarded as the Amaurobioidea. The Amaurobioidea, Kababininae, *Kababina*, *Carbinea*, *Malarina* and *Wabua* form well-resolved monophyletic clades. *Stiphidion* remains as the sister group to the Kababininae, however support is provided by characters found convergently in many other taxa of the Amaurobioidea that could not be included here. Placement of the subfamily within the Stiphidiidae on this basis is not reasonable.

The Amaurobioidea continues to form two distinct clades (Davies, 1999; Davies & Lambkin, 2000). In this analysis however *Amaurobius* (Amaurobiidae), *Paramatachia* and *Badumna* have moved from a basal position in the clade including the Kababininae to a basal position in the clade containing *Desis* (Desidae) and *Amphinecta* (Amphinectidae). The inclusion in one clade of the type genera of three families indicates one of the problems confronting systematists working on this diverse group.

Wabua contains two monophyletic species-groups *W. halifax* and *W. paluma*; *W. kirrama*, *W. eungella*, *W. aberdeen* and *W. crediton*. *Wabua* is distinct from the other genera of the Kababinae. *Kababina* remains basal, as found in earlier studies (loc. cit.) *Carbinea* and *Malarina* form a clade, as sister-group to *Wabua*. The grouping of *Carbinea*, *Malarina* and *Wabua* is based on the incontrovertible synapomorphy of the long, broad embolus. *Carbinea* and *Malarina* are separated from *Wabua* by their possession of the proximal parembolic apophysis. Therefore *Wabua* contains species that have a long broad embolus, but without a proximal parembolic apophysis.

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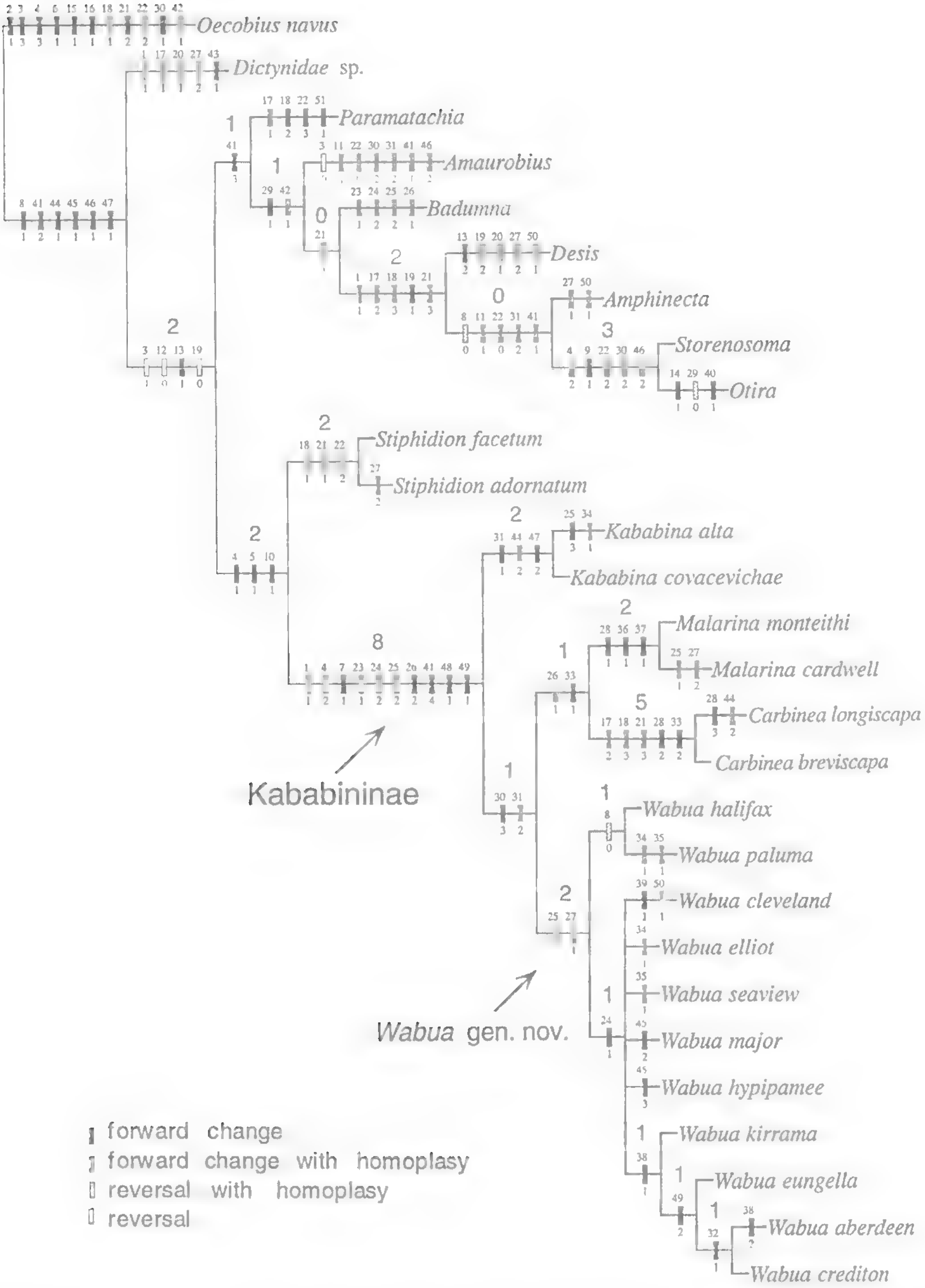

FIG. 12. Preferred most parsimonious tree showing the cladistic relationships of some Amaurobioidea. (Branch support shown above nodes).

which some of this material was collected and for the financial support of illustrator and co-author, Christine Lambkin, who also set up the cladistic analysis resulting in the cladogram. We are grateful for the support of other members of the Queensland Museum, particularly Katie Laws and Jennifer Cannon for their help in the preparation of this paper.

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TRUNK WINDOW TRAPPING: AN EFFECTIVE TECHNIQUE FOR SAMPLING TROPICAL SAPROXYLIC BEETLES

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Three techniques for trapping saproxylic (dead wood associated) beetles are compared, based on a study in an old-growth Australian lowland tropical rainforest. Trunk window traps, which are small flight intercept traps mounted on the sides of dead trees, are the most efficient, and are highly recommended for studies where high between-trap variability is not a major concern. Ground-based flight intercept traps collect fewer species, and sample a different, perhaps less substrate-specific, set of species. They are, however, useful for between-site comparisons since they have lower between-trap variability. Both techniques are cheap and simple to operate. Log emergence traps are the least efficient and their cost in time, effort and expense is high. They do, however, sample a few cryptic species not readily sampled by other means. All three techniques would be desirable for a comprehensive survey, but given time/cost constraints, trunk window traps alone are recommended. Despite a combined sampling intensity in this study equivalent to18 trap-years, the yield of 329 species from 59 traps may represent little more than half of the species potentially sampleable by these means. Thus whichever method is chosen, and whatever the objective, it is advisable to operate multiple traps continuously over several months during the season of insect activity. ❐ *saproxylic, Coleoptera, rainforest,Queensland, sampling, insect trap.*

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This paper compares a relatively new insect sampling technique, trunk window (TW) trapping, with the more established techniques using ground-based flight intercept (GFIT) and log emergence (LE) traps. All three techniques were used specifically to sample saproxylic beetles, as part of a wider investigation into the long-term impacts of logging in tropical rainforests on these organisms (to be reported elsewhere). The Daintree lowlands of northeast Queensland were chosen for this study since the region is relatively accessible, has a varied land-use history, and a fairly well-documented insect fauna (e.g. Monteith, 1985).

Saproxylic insects are those which depend on dead wood or wood-decaying fungi for at least part of their life cycle (Speight, 1989). They form a dominant functional group in any wooded environment. In temperate Europe, they are peculiarly sensitive to forest management, with many formerly common species now rare — some even regionally extinct — as a result of centuries of forest use and abuse (Kirby & Drake, 1993). Our understanding of forest ecosystems would suggest that much the same future awaits saproxylic insects wherever forests are subjected to heavy, long-term exploitation. However, there is currently no information available to support or refute this with regard to the world's tropical forests, where insect species richness is vast (Grove & Stork, 2000) and where exploitation rates seem set to escalate. There is thus a critical need for information on how forest management can be made ecologically sustainable, especially for saproxylic insects (Grove & Stork, 1999; Grove & Tucker, 2000).

MATERIALS AND METHODS

STUDY AREA. The research took place in the Daintree lowlands of northeast Queensland, a region with continuous lowland rainforest where areas of old-growth, logged and regrowth forest exist in relatively close proximity. Within this area, saproxylic beetles were sampled at nine sites differing in their management history. The sampling programmes described here refer to one of these, Thompson Creek (16°06'31"S 145°26'25"E), 4km south of Cape Tribulation on the northeasterly footslopes of Mount Hemmant, about 500m from the Australian Canopy Crane Facility. This site comprises old-growth, complex mesophyll vine forest 1a (Tracey & Webb, 1975), and lies at an altitude of 40-120m.

SAMPLING PROGRAMME. Sampling took place over the summers of 1997/98 and 1998/99. GFITs were placed every 50m along a 400m 'internal transect', making a total of 9 traps. The traps operated for about 17 weeks throughout the 1998 wet season, from January 10 to May 7. The following wet season, 26 TW traps and 24 LE traps were erected in the same area. The number of TW traps was limited by the availability of dead trees on which to mount them, while the number of LE traps was limited by cost and time constraints. The TW traps operated for about 8 weeks, from November 19 1998 until January 16 1999. Cyclone Rona destroyed most of them on February 11 1999, shortly before the next series of samples was due for collection. The LE traps operated for about 24 weeks, from November 19 1998 until May 5 1999, though several were destroyed by Cyclone Rona.

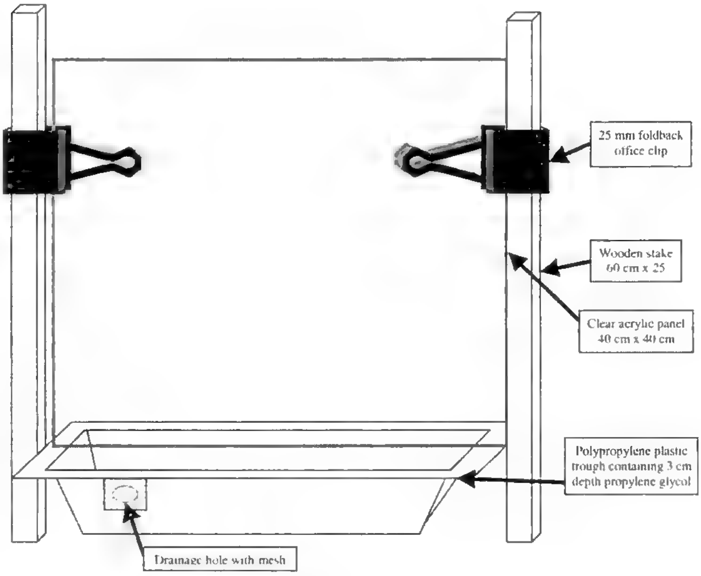

FIG. 1. Ground-based flight intercept trap.

TRAP DESIGN. *Ground-based Flight Intercept Traps.* Flight intercept traps consist of a vertical barrier to insect flight that is considered invisible to the insect. On hitting the barrier, most beetles drop down or attempt to circumvent the barrier by flying downwards. A collecting vessel placed beneath the barrier will catch many of these. GFITs have been widely used in Australia (e.g. Hill, 1993) since their first use in North America (Peck & Davies, 1980). The design used in this study (Fig. 1) is a scaled-down version of that regularly employed in the Wet Tropics by Monteith (pers. comm.). It consists of a 40cm square panel of 3mm clear acrylic clamped at each end with large foldback office clips to two vertical wooden stakes (25mm square section) driven into the ground. The acrylic panel is raised above the ground and its lower edge rests across the top of a 5 litre polypropylene ice-cream container (34cm long, 16cm wide, 12cm high) positioned on the ground lengthways between the two stakes. Propylene glycol is added to each container as collecting/preservative fluid. This is used in preference to ethylene glycol because of reduced vertebrate toxicity (Hall, 1991). The trap is protected from rain and debris by a roof of 0.2mm clear polythene rigged tentwise above it, such that the lower edges are no lower that the top of the acrylic panel. This roof is draped over a 1m high cord stretched lengthwise above the trap between two convenient trees and its four corners are tied with cord to nearby saplings, etc. Such a trap can operate for a month or more before the fluid needs augmenting. At clearing, the fluid is strained through a fine, nylon tea strainer and the catch transferred to 70% ethanol.

Trunk Window Traps. The concept of a flight intercept trap mounted above ground-level pre-dates that of GFITs (Chapman & Kinghorn, 1955). Aerial flight intercept traps have been further developed in Australia by Basset (1988) and Hill & Cermak, (1997). Kaila (1993) and Økland & Hågvar (1994) first employed flight intercept traps as TW traps specifically to sample saproxylic insects. The TW trap design used in this study applies their principles by modifying the standard GFIT so that it can be mounted on the side of a standing dead tree (Figs 2 & 3).

In the TW trap, the wooden support stake forms an inverted T-shape, the upright length being 45cm long and the cross-piece 15cm. A groove cut into the upright stake receives the acrylic panel. Three loose-fitting nails are fed through small holes in one side of the upright stake and lodge in similarly sized and spaced holes along one edge of the acrylic panel, thus holding the panel in place. The trap is anchored to the tree by an 8cm nail which passes through an angled hole in the top of the vertical stake and is hammered

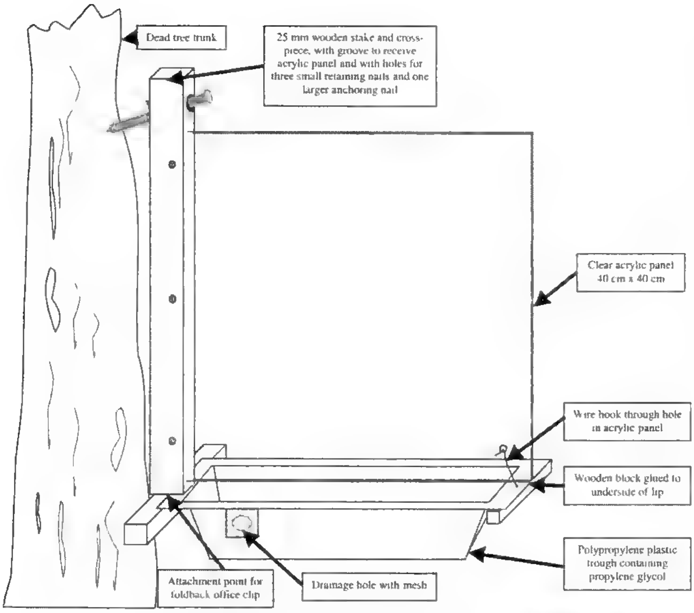

FIG. 2. Specifications of trunk window trap.

into the tree at head height. The corners of the lip of one end of the polypropylene container are clipped to the cross-piece using two foldback office clips. The other end is attached to the outer corner of the acrylic panel with a piece of wire, the bent tip of which feeds into a small hole near its corner. The container can readily be removed for emptying by unclipping the wire and clips. A roof of polythene sheeting is rigged up above the trap, again using cord tied at four corners and with a main taut 'strut' running along the axis of the trap from the tree-trunk to a nearby tree. To divert water running down the tree-trunk, the polythene is affixed to the tree at key points using small nails and plastic washers. Preservative and service procedures are as described for the ground-based FIT.

Log Emergence Traps. The LE (Fig. 4) is a modified version of one described by Owen (1989). It consists of an enclosed tent-like structure into which a standard volume (0.5m^3) of sawn-up dead wood derived from the target log is placed. Emerging insects head towards the light, where their only exit is through two tubes in the topmost corners of the tent, leading into collecting jars. The main tent material is black spun polypropylene mulch-matting, as recommended by Uffen (1998), with pore-size smaller than the smallest beetle. It has the advantage over other materials of maintaining the microclimate inside similar to outside, since it is permeable to air and moisture. The final trap dimensions are roughly 150cm long, 80cm wide, and 80cm high. Wood is inserted or removed by means of a sealable opening secured by velcro strips along one of the lower lengths of the trap and one of the adjacent sides; all other seams are permanently sewn closed. A sheet of polypropylene plastic laid on the ground beforehand reduces damage by roots, small mammals and soil-living invertebrates such as termites. The trap is kept in shape by guying to a wooden stake at each end. A collecting head at

FIG. 3. Trunk window trap, in situ.

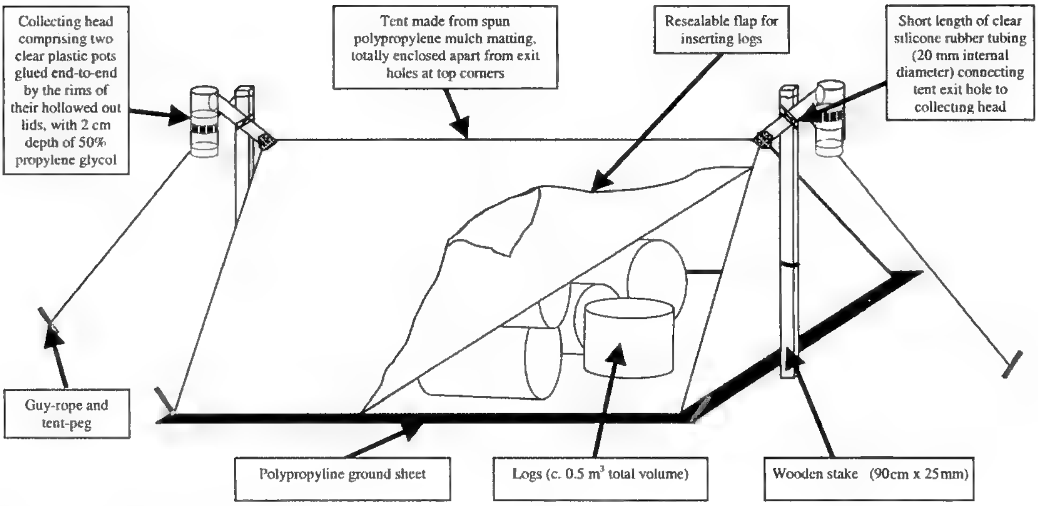

FIG. 4. Log emergence trap.

each end comprises a clear plastic funnel glued into the top corner of the main tent, connected by a short length of 20mm diameter silicone rubber tubing to an inverted 300ml plastic specimen jar, via a hole near its base (i.e. the top). A second specimen jar, fitted below this and attached by the rims of two jar lids glued back-to-back, serves as the collecting vessel, using 50% propylene glycol as the collecting and preserving fluid. The trap can operate for a month or more at a time; the lower jar is then unscrewed and replaced with a new one.

SPECIES IDENTIFICATION. Potentially saproxylic beetles were removed from the samples and initially identified to the level of morphospecies (Oliver & Beattie, 1996). Beetles were regarded as saproxylic if so suggested by their habitat associations recorded in the literature or during this study. Most Staphylinoidea, Nitidulidae and a few other difficult or poorly known groups were discounted since they were considered taxonomically intractable and/or their status as saproxylic beetles could not be ascertained. For the remainder, identification to family and sub-family level was readily accomplished using standard works (Lawrence & Britton, 1994). Tentative identification to species proved feasible for only about a third of these. Key publications include Slipinski (1988); Slipinski & Lawrence (1997); Calder, (1996); Matthews (1984, 1985, 1987, 1992); Zimmerman (1991, 1992, 1993a, 1993b, 1994) and Dibb (1938). Many species were identified with the help of other entomologists in Australia and overseas. Voucher specimens are lodged at the Queensland Museum (Brisbane), James Cook University (Cairns), Department of Primary Industries (Mareeba) and the Australian National Insect Collection (Canberra).

STATISTICAL ANALYSIS. Species diversity and community similarity statistics were calculated using the computer programs EstimateS (Colwell, 1997) and PC-ORD (McCune & Mefford, 1999).

RESULTS

The combined sampling intensity from all 59 traps represents the equivalent of 18 trap-years. Together, the three techniques produced 3399 specimens belonging to 329 species or morphospecies (Appendix 1). Table 1 gives some species richness and compositional attributes for the three techniques.

GENERAL TRAPPING EFFICIENCY. The three techniques differ markedly in the total numbers of species sampled, although the differences in sampling intensity and duration must be borne in mind. At the level of sampling effort used, TW traps fare best, with 233 species, representing 71% of the total species list sampled. LE traps sample 137 species (42%), while GFITs perform least well with 127 species (39%). When species richness is standardised to 9 traps using the Coleman richness expectation (based on a process similar to rarefaction

TABLE 1. Species richness and compositional attributes for trunk window (TW), log emergence (LE) and ground-based flight intercept (GFIT) trap sampling programmes at Thompson Creek. N = 329 species.

	TW (N = 26)	LE (N = 24)	GFIT (N = 9)
Total no. of species	233	137	127
No. of species as percentage of grand total	71	42	39
Coleman richness expectation for 9 random traps	142	85	127
Coleman richness expectation for 9 random traps as percentage of grand total	43	26	39
Mean no. of species per trap	8.6	5.7	14.1
Mean no. of species per trap-week	1.1	0.2	0.8
% of species represented by singletons	46	46	56
Abundance-based Coverage Estimator (ACE)	411	225	228
No. of species as percentage of ACE	57	61	56
No. of species unique to sampling technique	111	23	39
Multi-Response Permutation Procedures average Euclidean distance amongst samples	3.1	2.2	2.8

[Coleman, 1981]), TW traps still perform best (142 species, or 43% of the total species sampled), GFITs are not far behind (127 species or 39%), while LE traps perform much less well (85 species or 26%). Standardising to one trap suggests that GFITs perform best (14.1 species per trap compared to 8.6 for TW and 5.7 for LE). However, GFITs were sampling for much longer than TW traps. When different sampling durations are taken into account by standardising to one trap-week, TW traps perform best (1.1 species per trap-week) compared to 0.8 for GFIT and only 0.2 for LE. This is perhaps an unfair comparison since it does not take into account different intrinsic rates of species accumulation and between-trap heterogeneity, especially for LE traps since they sample the fauna present in dead wood at the time that the trap was erected, with no opportunity for colonisation by further species.

Randomised species accumulation curves (Fig. 5) suggest that no technique is yet close to capturing the full range of sampleable species. A large proportion of species in all three techniques occur as singletons, ranging from 46% for TW and LE traps to 56% for ground-based FITs. This suggests that there are many more species that have yet to be sampled because of their rarity or their cryptic nature. Many statistical methods exist to estimate total species richness by extrapolating from these curves or their underlying data. A recently devised and promising statistic is the abundance-based coverage estimator (ACE, Chao, Ma & Yang, 1993; Chazdon, 1996). ACE predicts notional 'total' species richness attainable using 24 TW traps as 411 species (suggesting 57% coverage so far), a much higher number than predicted to be attainable using either 26 LE traps (225 species or 61% so far), or 9 GFITs (228 species or 56% so far).

TRAP SELECTIVITY. The degree to which the different techniques overlap in the species they sample offers further insight into their effectiveness. TW traps again fare best, with 111 species not caught by other techniques. This compares with just 39 species caught only in GFITs and a mere 23 caught only in LE traps. In terms of overall similarity in species composition, a principal components analysis (PCA, Fig. 6) shows that the three techniques are largely separable by the assemblages of species they sample, so all are selective to some extent. There is a small amount of overlap between some TW and LE trap samples, while GFIT samples occupy a completely separate part of the ordination space.

TRAP SAMPLE HETEROGENEITY. Within-technique heterogeneity was investigated using the Multi-Response Permutation Procedures (MRPP) running in PC-ORD, employing the recommended Euclidean distance measure and n/sum (n) weighting of groups. MRPP is a non-parametric procedure whose primary use is for testing the hypothesis of no difference between two or more groups of entities (in this case sampling techniques). Of particular use here is that MRPP also reports the average Euclidean distance between members of each group. For TW, this is 3.1, for LE 2.2 and for GFIT 2.8. In other words, TW samples are the most heterogeneous (high between-trap variability), LE samples the most homogeneous (low between-trap variability), and GFIT samples intermediate.

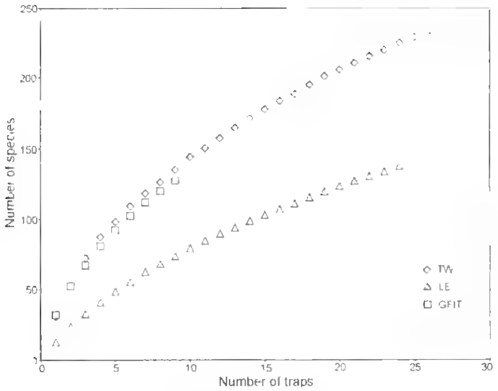

FIG. 5. Randomised species accumulation curves for the three sampling techniques, based on total number of traps at Thompson Creek. Note that different techniques used different numbers of traps: 26 for trunk window (TW); 24 for log emergence (LE); 9 for ground-based flight intercept traps (GFIT). Note also that the curves do not provide a direct measure of trap efficiency since individual traps in different techniques were sampling for different lengths of time.

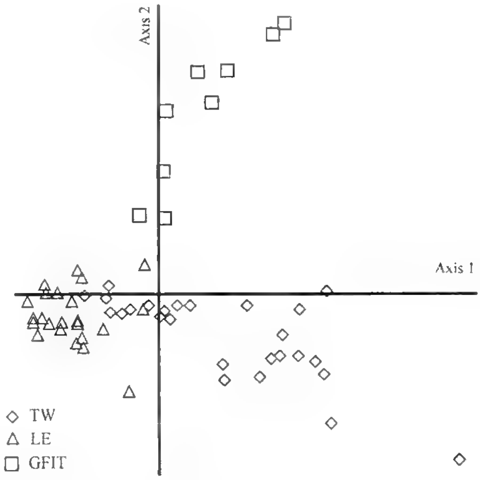

FIG. 6. Ordination plot (first two axes) from a principal components analysis (variance-covariance, on $\log_{10}+1$ transformed abundance data) of saproxylic beetles sampled using trunk window (TW), log emergence (LE) and ground-based flight intercept (GFIT) traps at Thompson Creek. N = 329 species.

DISCUSSION

Trapping efficiency is a key consideration for most types of insect survey (Muirhead-Thomson, 1991). The definition of efficiency depends on the objective of the study. Where the aim is to collect as many species as possible, as efficiently as possible, the best strategy is to select a technique, or combination of techniques, that targets the species in question. Where the aim is to compare two or more sites on the basis of their species composition, it is more important that sampling effort be standardised. For both these objectives, time and money are always further considerations. Given these considerations, how do the three sampling techniques compare?

TW traps are cheap, simple and robust under normal (non-cyclone) rainforest conditions. They are very efficient at sampling saproxylic beetles when mounted on standing dead tree trunks as in this study. Each trap produces more species than either of the other techniques, and the rate at which species accumulate with successive traps is also higher, with little indication of reaching an asymptote even with 24 such traps in operation over eight weeks. Many species are caught by this technique but not by the others at comparable sampling intensities. The species composition of TW trap samples varies more than other techniques, but is generally more similar to that of LE trap samples than GFITs. This suggests that they are effective at sampling the fauna of the dead standing trees on which they are mounted. All these attributes imply that TW traps represent a valuable technique for sampling saproxylic beetles where the objective of study is either a thorough species inventory or a comparison of different substrates (e.g. dead trees versus living trees, or trees with shelf-fungi versus trees without shelf-fungi). However, this substrate specificity and the high rate of species accumulation also makes the design less suitable for a comparison of sites, since it would be difficult to standardise the location of traps unless a sufficiently large pool of dead standing trees were available at each site.

GFITs are cheap to produce, easy to operate and durable under rainforest conditions. Unfortunately, they are not especially efficient at sampling saproxylic beetles — at least, not in the design used in this study. Not only do they catch fewer species per trap than TW traps, but the rate at which successive traps accumulate more species is also slightly lower, and rather few of these species are not caught by other techniques. Those species which are uniquely caught by GFITs may include less substrate-specific species — which may account for their absence in other sample types. On the other hand, many studies show that GFITs sample insects from a wide area and are relatively immune to the effects of habitat patchiness in their immediate vicinity (Siitonen, 1994; Økland, 1996) — perhaps picking up species dispersing from one habitat patch to another. Coupled with the fact that between-trap heterogeneity is lower than TW traps, this makes them suitable for studies where the objective is to compare between sites using multiple traps per site.

Log emergence traps are expensive to make, time-consuming to erect and stock with logs, and have relatively short life under rainforest conditions. They sample relatively few species per trap, and few of these are not sampleable by other techniques. Thus log emergence traps cannot be recommended as a standard sampling technique. They may still have a useful role if time and money are not limiting, and if the objective of the study is either a thorough species inventory or to determine which species occur in clearly delimited substrates.

It is clear that no single technique will adequately sample the entire saproxylic fauna, but trunk window traps come closest to doing so and represent a sampling option that deserves wider consideration. Even so, it is evident that, in tropical forests at least, large numbers of traps would be required over several months or years to reach species saturation.

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APPENDIX 1

Species list for saproxylic beetles at Thompson Creek, from the three sampling techniques. GFIT = Ground-based flight intercept trap; LE = Log emergence trap; TW = Trunk window trap.

Species	GFIT	LE	TW
RHYSODIDAE			
Kaveinga abbreviata (Lea, 1904)	0	0	7
Kaveinga frontalis (Grouvelle, 1903)	1	5	7
Rhyzodiastes mirabilis (Lea, 1904)	11	16	3
CARABIDAE			
Ametroglossus ater (Macleay, 1887)	0	0	1
Pogonoglossus 'sp. nov. 01'	1	1	2
Perigona rufilabris (Macleay, 1871)	5	3	3
Dolichoctis striata Schmidt-Goebel, 1846	1	0	1
Distipsidera flavipes Macleay, 1887	1	0	1
Distipsidera parva Macleay, 1887	1	0	4
HISTERIDAE			
Platylomalus terrareginae (Blackburn, 1903)	5	4	2
Platylomalus saucius (Blackburn, 1903)	1	0	0
Platysoma sp. agg. 01	3	0	37
STAPHYLINIDAE			
Priochirus miles Bernhauer	8	9	0
SCIRTIDAE			
Scirtidae sp. 01	0	5	0
Prionocyphon sp. 01	0	0	1
LUCANIDAE			
Prosopocoilus torresensis (Deyrolle, 1870)	0	0	8

Species	GFIT	LE	TW
PASSALIDAE			
Aulacocyclus fracticornis Kuwert, 1891	7	26	8
Mastachilus australasicus (Percheron, 1841)	2	4	3
CERATOCANTHIDAE			
Pterorthochaetes simplex (Gestro, 1899)	1	1	12
SCARABAEIDAE			
Australoxenella concinna Storey & Howden, 1996	2	0	1
Daintreeola grovei Storey & Howden	0	0	3
Glycyphana pusilla Bacchus, 1974	0	1	0
Ischiopsopha wallacei (Thomson, 1860)	0	0	5
CALLIRHIPIDAE			
Ennometes sp. 01	0	0	5
Ennometes sp. 02	0	0	1
PTILODACTYLIDAE			
Ptilodactyla sp. 01	116	12	25
Ptilodactyla sp. 02	54	37	12
CHELONARIIDAE			
Chelonarium australicum Lea, 1918	0	0	1
EUCNEMIDAE			
Melanoscython sp. 01	1	0	0
Fornax sp. 01	0	4	1
Fornax sp. 02	0	1	1
Microrhagus sp. 01	0	1	1
Microrhagus sp. 02	0	0	1
Microrhagus sp. 03	0	0	1
Microrhagus sp. 04	1	1	0
Microrhagus sp. 05	2	0	1
Agalba sp. 01	0	0	1
Agalba sp. 02	0	0	1
Galbodema mannerheimi LaPorte, 1835	0	3	0
Dromaeoloides sp. 01	0	1	0
Euryptychus sp. 01	0	0	3
Euryptychus sp. 02	1	0	0
Dromaeolus sp. 01	0	0	1
Rhagomicrus sp. 01	0	0	1
Eucnemidae gen. nov. sp. 01	0	0	1
Hemiopsida sp. 01	1	0	0
THROSCIDAE			
Throscidae sp. 01	0	0	1
Potergus sp. 01	0	0	3
Aulonothroscus sp. 01	0	3	0
ELATERIDAE			
Elateridae sp. 03	17	2	3
Agrypnus sp. 01	10	3	5
Anilicus 'sp. nov.'	0	0	2
Megapenthes sp. 01	1	0	3
Megapenthes sp. 02	4	0	2
ELATERIDAE (cont.)			
Megapenthes sp. 03	2	3	1
Melanoxanthus sp. 01	9	24	8
Melanoxanthus sp. 03	0	0	1
Melanoxanthus sp. 06	1	0	2
Melanoxanthus sp. 07	0	0	2
Cardiotarsus sp. 01	1	0	0
Cardiotarsus sp. 02	0	0	1
Paracardiophorus sp. 01	20	0	1
Paracardiophorus sp. 02	14	0	1
LYCIDAE			
Trichalus sp. 01	1	2	0
Trichalus sp. 02	4	6	0
Trichalus ater (Macleay, 1887)	1	1	0
Cladophorus sp. 01?	0	1	0
Xylobanus (*?Stadenus*) *ampliatus* Macleay, 1887	2	3	0
CANTHARIDAE			
Sphaerarthrum rubriceps (Macleay, 1887)	0	1	0
Heteromastix sp. 01	8	14	0
Heteromastix sp. 02	0	1	0
JACOBSONIIDAE			
Gomya sp. 01	0	0	1
Sarothrias lawrencei Lobl & Burckhardt, 1988	3	2	28
NOSODENDRIDAE			
Nosodendron interruptum (Lea, 1931)?	1	0	18
ANOBIIDAE			
Pronus sp. 01	0	1	0
Mysticephala sp. 01	0	0	9
TROGOSSITIDAE			
Larinotus umbilicatus (Carter & Zeck, 1937)	0	0	2
Neaspis sp. 01	0	1	0
CLERIDAE			
Ommadius yorkensis Kuwano	0	3	0
Ommadius sp. 03	0	0	1
Isoclerus gerstmeieri Kolibac, 1998	0	0	1
MELYRIDAE			
*Carphurus armipennis*Fairmaire, 1879	0	0	1
SPHINDIDAE			
Aspidiphorus sp. 01	10	4	82
NITIDULIDAE			
Brachypeplus caudalis Murray	14	1	1
MONOTOMIDAE			
Mimemodes laticeps Macleay	0	1	3
Mimemodes sp. 01	0	1	0
Shoguna termitiformis Fairmaire	7	7	11
SILVANIDAE			
Psammoecus 'ANIC sp. 01'	3	1	1
Monanus 'ANIC sp. 01'	1	0	1

Species	GFIT	LE	TW
LAEMOPHLOEIDAE			
Laemophloeidae sp. 03	1	0	0
Laemophloeidae sp. 04	0	0	1
Laemophloeidae sp. 05	0	0	4
Microlaemus brightensis (Blackburn)	0	0	3
Laemophloeus sp. 01	3	0	2
Mariolaemus sp. 01?	1	1	0
Rhabdophloeus conterminus (Olliff)	0	0	1
Xylolestes ovalis (Grouvelle)?	1	0	1
PROPALTICIDAE			
Propalticus simplex Crowson & Sen Gupta, 1969	0	0	3
PHALACRIDAE			
Phalacridae sp. 01	5	0	3
CRYPTOPHAGIDAE			
Microatomaria hintoni Leschen, 1996	2	2	1
EROTYLIDAE			
Microsternus sp. 01	0	0	1
Episcaphula sp. 01	0	0	1
BIPHYLLIDAE			
Biphyllus obscuronotatus (Lea, 1922)	11	2	23
Biphyllus ornatellus Blackburn	0	0	2
BOTHRIDERIDAE			
Teredolaemus sp. 02	1	1	0
CERYLONIDAE			
Australiorylon neboissi Slipinski, 1988	42	1	34
Australiorylon setosus Slipinski, 1988	8	0	8
Cautomus mirabilis (Oke, 1932)	3	0	5
Cerylonopsis doyeni Slipinski, 1988	0	0	21
Lapethus astrolabei Heinze, 1944	3	2	6
Philothermus microsetosus Slipinski, 1988	41	4	31
Euxestus matthewsi Slipinski, 1988	15	3	27
DISCOLOMATIDAE			
Aphanocephalus sp. 01	2	25	44
Aphanocephalus poropterus Lea, 1922?	1	0	1
ENDOMYCHIDAE			
Endomychidae sp. 01	1	2	0
Endomychidae sp. 03	0	0	57
Endomychidae sp. 04	0	1	1
Endomychidae sp. 05	1	1	0
Endomychidae sp. 06	0	0	1
Erotendomychus n. sp. 01	0	1	0
Idiophyes brevis Blackburn, 1895?	0	0	3
Stenotarsus pisoniae Lea	4	3	6
COCCINELLIDAE			
Coccinellidae sp. 01	1	1	0
Coccinellidae sp. 02	0	1	0
Coccinellidae sp. 03	0	1	0
Sticholotidinae sp. 01	1	3	3
Telsimia sp. 01	1	1	0

Species	GFIT	LE	TW
CORYLOPHIDAE			
Holopsis sp. 02	0	0	15
Holopsis sp. 03	3	1	2
Parmulus sp. 01	98	21	45
Parmulus sp. 02	1	1	0
LATRIDIIDAE			
Bicava castanea (Broun)	0	0	2
Bicava sp. 01	9	0	21
Bicava sp. 02	5	0	39
Aridius sp. 01	3	0	0
CIIDAE			
Octotemnus sp. 01?	0	0	1
Octotemnus sp. 02	0	0	1
Cis sp. 01	14	12	123
Cis sp. 02	4	0	6
Cis sp. 03	5	4	20
Cis sp. 04	0	0	2
Cis sp. 05	2	0	0
Cis sp. 06	0	0	1
Cis sp. 07	1	0	1
Cis sp. 09	0	0	1
Cis sp. 10	2	0	0
Cis 'sp. 886'	1	1	2
Euxestocis sp. 01	0	0	125
Neoennearthron sp. 01	2	2	0
Orthocis sp. 01	0	0	3
Orthocis sp. 02	0	0	4
MELANDRYIDAE			
Orchesia sp. 01	1	0	0
MORDELLIDAE			
Mordellidae sp. 01	4	0	6
Mordellidae sp. 02	0	0	1
Mordellidae sp. 03	0	0	1
Mordellidae sp. 04	0	0	2
Mordellidae sp. 07	1	0	0
Mordellidae sp. 11	0	0	1
Mordellidae sp. 12	0	1	0
Mordellistena coelioxys Lea?	9	1	11
Plesitomoxia 'ANIC sp. 03'	1	0	0
ZOPHERIDAE			
Ablabus queenslandicus Slipinski	1	2	1
Antilissus sp. 01	0	0	1
Colobicones alfa Slipinski, 1999	2	1	1
Colobicones australis Slipinski, 1999	4	0	2
Colobicones oculatus Slipinski, 1999	5	0	19
Colobicones papuanus Slipinski?	1	0	0
Pseudendestes australis Lawrence, 1980	2	6	1
Tentablabus fulvus Slipinski & Lawrence, 1997	0	0	2
Synchita ?fasciata (Carter & Zeck, 1937)	1	0	0
Pycnomerus 'n. sp.' 01	3	0	27

Species	GFIT	LE	TW
TENEBRIONIDAE			
Dimorphochilus flavicornis (Macleay)	1	0	1
Alleculinae sp. 01	0	0	1
Hypaulax tenuistriata Bates, 1874	1	1	0
Promethis carteri Kaszab	0	0	1
Chariotheca doddi Carter, 1924	0	0	1
Chariotheca planicollis (Fairmaire, 1849)	0	0	1
Ceropria maculata Gebian, 1911	0	0	1
Corticeus sp. 02	1	1	0
Menimus sp. 01	9	9	74
Menimus sp. 02	0	1	2
Menimus neboissi Kaszab?	23	21	13
Platydema sp. 01	0	2	14
Platydema sp. 02	2	2	6
Archaeoglenes australis Doyen & Lawrence, 1979	1	0	0
Pseudophthora wilsoni Kaszab, 1978	0	0	1
Dioedus sp. 01	0	0	2
Dioedus sp. 02	0	1	1
Asphalus rectibasis (Carter, 1914)	0	0	1
Byrsax pinnaticollis Carter, 1914	0	0	10
Mychestes sp. 01	1	1	0
Paraphanes nitidus Macleay, 1888	0	0	3
Rhipidandrus simsoni Waterhouse, 1894	0	0	6
Uloma sanguinipes (Fabricius, 1775)	0	3	0
Uloma westwoodi Pascoe, 1863	0	0	1
PYROCHROIDAE			
Morpholycus flabellicornis (Macleay, 1887)	5	5	0
ANTHICIDAE			
Lemodes caeruleiventris Blair, 1913?	0	7	2
Tomoderus tricoloricornis (Lea)	4	2	13
Tomoderus sp. 01	1	1	0
Pseudotomerus sp. 01	1	0	0
ADERIDAE			
Aderidae sp. 01	1	0	1
Aderidae sp. 02	2	8	20
Aderidae sp. 03	0	0	1
Aderidae sp. 05	0	0	2
Aderidae sp. 07	1	0	0
Aderidae sp. 10	15	0	1
SCRAPTIIDAE			
Scraptia sp. 02	0	0	1
CERAMBYCIDAE			
Ceresium sp. 01	1	1	0
Lamiinae sp. 01	6	6	0
Lamiinae sp. 02	1	0	0
Dihammus (Acalolepta) argentatus (Aurivillius)	2	4	0
ADERIDAE (cont.)			
Dihammus (Acalolepta) aestheticus (Olliff)	0	1	0
Disterna mastersi (Pascoe)?	0	0	1
Cyocyphax praonethoides Thomson, 1878	0	1	0
Somatidia sp. 02	1	0	0
Aesa sp. 01	0	0	1
Archetypus fulvipennis (Pascoe)	0	1	0
ANTHRIBIDAE			
Araeocerodes sp. 01	4	0	5
Araeocerodes sp. 03	0	0	1
Araeocerodes sp. 04	0	1	1
Araeocerodes sp. 05	0	1	12
Misthosima 'new species 01'	0	0	2
Stenorhis 'new species 03'	0	0	4
Anthribinae sp. 02	0	0	1
Anthribinae sp. 06	1	0	0
Anthribinae 'genus P new sp. 01'	4	4	0
Basitropis relicta Blackburn, 1900	1	1	0
Commista latifrons Jordon, 1895	2	2	0
Eupanteos ornatus Jordan, 1923	0	0	1
Mauia subnotatus (Boheman, 1859)	0	0	1
Mauia sp. 01	0	0	1
Notoecia reticulata Blackburn, 1900	3	3	1
BRENTIDAE			
Brentinae sp. 03	1	1	0
Ectocemus decemmaculatus (Montrouzier, 1855)	1	0	0
Brentinae 'Qld genus C' sp. 01	1	0	2
Cordus 'new species 5'	0	0	1
Ithystenus hollandiae (Boisduval, 1835)	17	16	1
Mesoderes guttatus (Kleine, 1916)	0	1	1
CURCULIONIDAE			
Eutinophaea variegata Lea, 1904?	1	16	30
Cossoninae sp. 01	2	0	0
Cossoninae sp. 02	0	0	1
Cossoninae sp. 04	1	0	0
Cossoninae sp. 05	0	0	1
Cossoninae sp. 06	1	0	0
Cossoninae sp. 08	0	3	1
Cossoninae sp. 10	3	0	4
Cossoninae sp. 11	2	8	18
Cossoninae sp. 12	0	0	1
Cossoninae sp. 14	0	0	1
Cossoninae sp. 15	0	0	1
Cossoninae sp. 16	1	0	4
Cossoninae sp. 18	0	3	1
Cossoninae sp. 20	1	1	0
Cossoninae sp. 21	0	1	0

Species	GFIT	LE	TW
CURCULIONIDAE (cont.)			
Cossonus sp. 02	1	0	0
Cossonus nigroapicalis Lea, 1909	0	1	3
Cryptorhynchinae sp. 01	15	0	1
Cryptorhynchinae sp. 03	4	3	0
Cryptorhynchinae sp. 04	3	0	1
Cryptorhynchinae sp. 05	1	0	0
Cryptorhynchinae sp. 06	0	0	1
Cryptorhynchinae sp. 08	1	0	0
Cryptorhynchinae sp. 10	3	0	0
Cryptorhynchinae sp. 12	6	17	21
Cryptorhynchinae sp. 14	0	0	1
Cryptorhynchinae sp. 15	17	32	55
Cryptorhynchinae sp. 16	19	30	86
Cryptorhynchinae sp. 24	0	1	3
Cryptorhynchinae sp. 25	2	3	1
Cryptorhynchinae sp. 26	3	2	0
Cryptorhynchinae sp. 29	2	1	0
Cryptorhynchinae sp. 31	1	0	0
Cryptorhynchinae sp. 32	0	1	0
Cryptorhynchinae sp. 33	0	0	2
Cryptorhynchinae sp. 35	1	1	0
Cryptorhynchinae sp. 36	0	0	1
Cryptorhynchinae sp. 37	29	35	6
Cryptorhynchinae sp. 38	0	0	3
Cryptorhynchinae sp. 40	2	0	0
Cryptorhynchinae sp. 41	1	0	0
Cryptorhynchinae sp. 43	0	0	3
Cryptorhynchinae sp. 45	0	0	1
Cryptorhynchinae sp. 48	0	0	1
Cryptorhynchinae sp. 51	1	1	1
Cryptorhynchinae sp. 52	0	0	4
Cryptorhynchinae sp. 54	0	1	0
Cryptorhynchinae sp. 55	0	0	1
Cryptorhynchinae sp. 56	0	0	1
Mormosintes rubus Pascoe, 1865?	2	2	5
Acrotychreus sp. 01	1	0	0
Anchithyrus caliginosus Lea, 1912?	1	4	20
Austrectopsis oblonga Lea, 1912	0	0	1
CURCULIONIDAE (cont.)			
Dysopirhinus grandis Lea, 1903	0	6	1
Imaliodes ovipennis Lea, 1912	0	0	1
Mechistocerus cancellatus Lea, 1909	10	36	11
Nechyrus sp. 01	1	0	0
Nechyrus mollipes Lea, 1907	2	2	0
Trigonopterus albidosparsa (Lea, 1912)	0	1	1
Tyrtaeosus brevirostris Lea, 1913	1	1	5
Psepholacini sp. 01	0	0	1
Crossotarsus nitescens Schedl, 1979?	1	0	0
Diapus pusillimus Chapuis, 1865	3	3	3
Treptoplatypus australis (Chapuis, 1865)	0	0	1
Platypus queenslandi Schedl	0	0	7
Platypus carbonescens (Beeson)?	0	46	2
Scolytinae sp. 03	2	0	0
Scolytinae sp. 05	0	0	1
Scolytinae sp. 07	0	0	1
Scolytinae sp. 08	0	0	3
Scolytinae sp. 09	0	0	1
Scolytinae sp. 10	0	0	1
Scolytinae sp. 11	1	0	0
Scolytinae sp. 14	0	0	1
Scolytinae sp. 16	0	0	48
Scolytinae sp. 20	3	0	0
Xyleborus sp. 02	5	0	6
Xyleborus sp. 03	2	0	1
Xyleborus insulindicus Eggers, 1923	2	0	9
Xyleborus similis Ferrari, 1867	14	16	138
Xyleborus perforans (Wollaston, 1857)?	6	1	11
Xyleborus ferrugineus (Fabricius)	1	1	13
Xylosandrus morigerus (Blandford, 1894)	2	0	0
Hypothenemus eruditus Westwood, 1836	1	0	2
Euwallacea fornicatus (Eichhoff)	12	0	35
Euwallacea wallacei (Schedl)	1	0	6
Mecopus pictus Lea, 1910	1	1	0
Dryophthoroides sp. 01	0	0	7
Dryophthorus sp. 01	4	0	0

A REVIEW OF THE AUSTRALIAN SCHIZOMID GENUS *NOTOZOMUS* (HUBBARDIIDAE)

MARK S. HARVEY

Harvey, M.S. 2000 12 31: A review of the Australian schizomid genus *Notozomus* (Hubbardiidae). *Memoirs of the Queensland Museum* **46**(1): 161-174. Brisbane. ISSN 0079-8835.

The schizomid genus *Notozomus* Harvey, 1992 is reviewed and nine new species are described: *N. boonah*, *N. bronwenae*, *N. curiosus*, *N. elongatus*, *N. faustus*, *N. jacquelinae*, *N. majesticus*, *N. maurophila* and *N. wudjl*. *Apozomus spec* Harvey, 1992 is transferred to *Notozomus*, forming the new combination *N. spec* (Harvey, 1992), and the female is described for the first time. The male of *N. ingham* is described for the first time. Most species are found to occupy small ranges, which may be consistent with speciation events during the mid-Tertiary, rather than being associated with the fragmentation of rainforest habitats during the Pleistocene aridity events in eastern Australia. ❑ *Arachnida, Schizomida, Hubbardiidae, Notozomus, Australia, taxonomy, biogeography, rainforests.*

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Members of the arachnid order Schizomida are found mostly in tropical and sub-tropical zones of the world, with some small extensions outside of this zone into neighbouring areas. Possibly the most interesting are members of the genus *Hubbardia* Cook which occur in the coastal and montane regions of southwestern USA (Reddell & Cokendolpher, 1995). Others, such as the facultative parthenogenic *Stenochrus portoricensis* Chamberlin, is widely distributed around the world, probably due to synanthropic activity (Reddell & Cokendolpher, 1995). Many of the genera currently recognised possess relatively restricted distributions, but further work on the Asian and African faunae is needed to firmly establish the boundaries of the Old World genera.

In a revision of the schizomid fauna of Australia, Harvey (1992) recognised a number of new genera, including *Notozomus*, which appeared to be endemic to the rainforest patches of the northeastern Queensland wet tropics. Although Harvey (1992) recognised seven species of *Notozomus*, it has become clear through further examination of collections that the genus is more diverse than previously suspected. Herein I describe nine new species and transfer *Apozomus spec* Harvey, 1992 to *Notozomus*, based upon the newly discovered female possessing the spermathecal morphology characteristic of *Notozomus*. This brings the number of described species to 17, making it one of the most diverse schizomid genera.

Methods follow Harvey (1992) and Reddell & Cokendolpher (1995). Specimens utilised in this study are lodged in the California Academy of Sciences, San Francisco (CAS), Queensland Museum, Brisbane (QM), University of Queensland Insect Collection (UQIC), and the Western Australian Museum, Perth (WAM). Common collector's names are abbreviated as follows: DC, D.J. Cook; MC, M. Cermak; MH, M.S. Harvey; MS, M. Shaw; PL, P. Lawless; GM, G.B. Monteith; RR, R.J. Raven; BS, B.J. Scott; GT, G.I. Thompson. Leg segments in the dimensions lists are abbreviated as follows: CL, claw; FE, femur; ME, metatarsus; PA, patella; TA, tarsus, TI, tibia; TR, trochanter.

Family HUBBARDIIDAE Cook, 1899
Subfamily Hubbardiinae Cook, 1899
Notozomus Harvey, 1992

Notozomus Harvey, 1992: 112; Reddell & Cokendolpher, 1995: 83.

TYPE SPECIES. *Notozomus aterpes* Harvey, 1992, by original designation.

DIAGNOSIS. *Notozomus* differs from all other Australasian schizomids by the following combination of characters: pedipalpal trochanter with mesal spur; movable cheliceral finger without accessory teeth in most species, although a small tooth is present in two species; female genitalia with gonopod and with chitinised arch, and with 4 spermathecae consisting of slender ducts terminating in ovoid or elongate receptacula; male flagellum dorso-ventrally flattened.

DESCRIPTION. Body without clavate setae. Anterior process of propeltidium with pair of setae followed by single seta; corneate eyes absent; metapeltidium divided. Pedipalp not sexually dimorphic and without armature except for mesal spur on trochanter; male pedipalps not dimorphic. Moveable cheliceral finger either without accessory teeth or with a raised mound, and with a guard tooth at end of serrula. Antero-dorsal margin of femur IV produced at about 90°. Abdominal tergite II with 2 posterior setae; male abdomen not elongated; male with small development of posterodorsal process on abdominal segment XII. Male flagellum ovoid and dorso-ventrally flattened; female flagellum with four segments. Spermathecae consisting of two pairs of spermathecae with long, slender ducts terminating in ovoid or elongate receptacula, usually with nodules; gonopod distally rounded, not bifurcate.

DISTRIBUTION AND BIOGEOGRAPHY. Within Australia, *Notozomus* appears restricted to eastern Queensland, and is known with certainty as far north as Mt Finlay (*N. daviesae*) and as far south as Boonah (*N. boonah*). However, a single juvenile of an unidentified species from Mt Cook National Park (NP), some 40km north of Mt Finlay, was recorded by Harvey (1992), indicating that further species may yet be uncovered. Most species are found in rainforest habitats or their margins between Mt Finlay and Mt Spec, with only *N. jacquelinae* (Mt Abbot), *N. faustus* (Conway NP), *N. bronwenae* (Eungella NP) and *N. boonah* (near Boonah) occurring outside of this area (Fig. 1). The only other schizomids which occur in Queensland south of Mt Finlay are the two described species of *Julattenius*, *J. lawrencei* Harvey from Julatten and *J. cooloola* Harvey from the Cooloola region, and the three known species of *Brignolizomus*, *B. woodwardi* (Harvey) and *B. walteri* Harvey, from the Brisbane region, and *B. nob* (Harvey) from Byfield (Harvey, 1992, 2000). Species of *Notozomus* appear to be allopatric with other genera such as *Apozomus* Harvey which occurs in the drier regions to the north and west of the main distribution of *Notozomus*: *A. weiri* Harvey occurs in the McIlwraith Range, *A. cactus* Harvey at Iron Range (Harvey, 1992), and undescribed species of *Apozomus* and *Bamazomus* from the limestone karst systems of the Chillagoe region (Harvey, in press). Further species of *Bamazomus* Harvey occur even further to the north (Harvey, 1992, unpubl. data).

Although all *Notozomus* species treated herein are restricted to Queensland, two female specimens collected from New Caledonia (entreé de la grotte Yane Wahiobi, Ile de Lifou,.viii.1995, J. Lips, currently lodged in WAM) have been examined which possess all major features of the genus. I postpone description of that species until I examine all existing New Caledonian collections and establish the full extent of the fauna.

One of the most obvious features of the distribution patterns displayed within *Notozomus* is the highly disjunct distributions and the high levels of allopatry (Fig. 1). The presence of 13 species occurring between Mt Finlay and Mt Spec, in addition to a species of *Julattenius* also occurring within this sector (Harvey, 1992), makes it one of the most speciose regions in the world for schizomids.

Such levels of diversity and extreme allopatry have been reported sparingly for other invertebrate taxa within northeastern Queensland. Raven (1984, 1993) recorded seven species of the mygalomorph genus *Namirea* from rainforest habitats ranging from northeastern Queensland to the Blue Mountains, New South Wales, but only two species were recorded north of Townsville. Raven (1994) detected rampant speciation amongst various genera of barychelid mygalomorph spiders in northeastern Queensland, especially within the genera *Mandjelia* Raven, *Moruga* Raven and *Trittame* Koch. Platnick & Forster (1989) documented the rich anapid spider fauna of the region, and each of the nine species of *Spinanapis* Platnick & Forster had relatively small ranges. Monteith (1997) demonstrated high diversity amongst mezirine flat bugs, but most species were widely distributed. Hill (1984) described a number of hypselosomatine bugs with extremely small distributions, especially amongst those taxa occuring in the wet tropics. Baehr (1995) documented the high diversity and highly localised distributions of the 35 species of the primitive carabid beetle genus *Philipis* Erwin, which were found discontinuously distributed throughout the rainforests of eastern Queensland. The sole widespread species, *Philipis thompsoni* Baehr, ranges from Kuranda in the north to Cardwell Range in the south. A further 31 species occur between Cooktown and Innisfail, generally with small ranges. The remaining three species occur in rainforest remnants well to the south: *P. ellioti* Baehr at Mt Elliot near Townsville, *P. atra* Baehr at Mt Macartney, and *P. subtropica* Baehr at the Lamington and Springbrook Plateaus in southeastern Queensland (Baehr 1995: fig. 17). The congruence between the distribution patterns of *Philipis* and *Notozomus* (Fig. 1) is particularly striking, as both possess a core of species in the

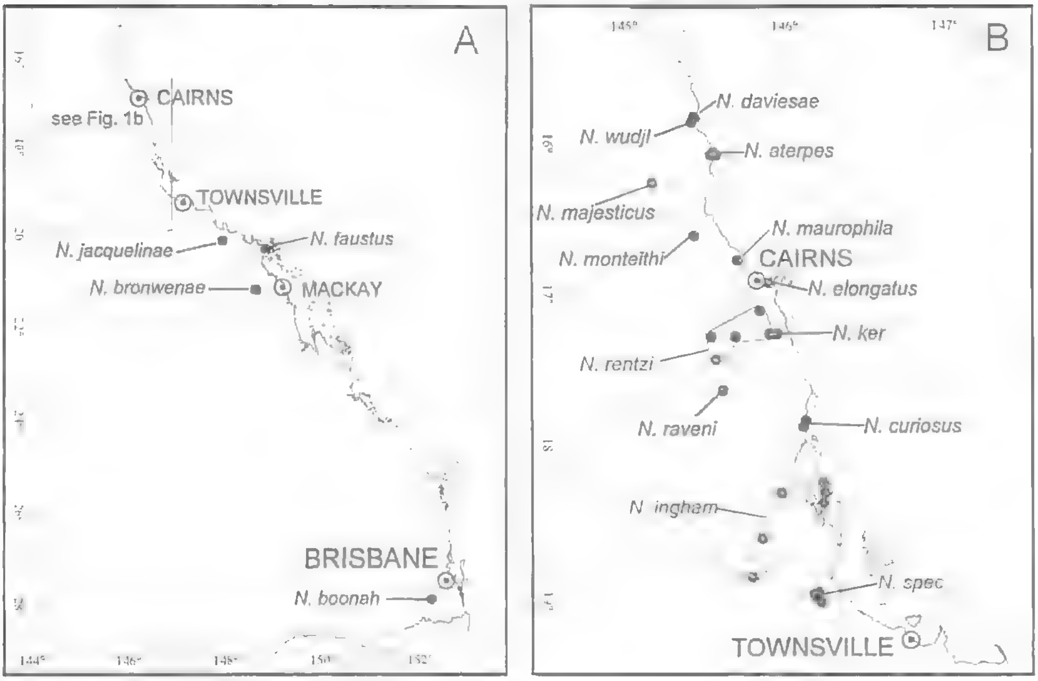

FIG. 1. Known distribution of *Notozomus* species.

Wet Tropics, with peripheral species occurring to southeastern Queensland.

Comparative phylogenetic studies on animals with diverse life history traits and ecological requirements will probably assist in providing answers to the questions posed by tropical rainforest vicariance in northern Queensland (Joseph et al., 1995).

Schizomids are generally restricted to humid habitats, either in rainforests, caves or in hothouses (Reddell & Cokendolpher, 1995). Whilst many of the specimens treated below are from rainforest habitats, several specimens were collected at rainforest margins, such as in casuarina or eucalypt woodland. The importance of these findings is difficult to interpret, but it may indicate that schizomids are capable of dispersing between discrete rainforest patches to colonise new areas. However, this is not borne out by the distributional data (Fig. 1), which suggest that the high levels of endemism are due to fragmentation of potential habitat.

The highly localised distributions of *Notozomus* species, as well as those of other schizomids (e.g. Harvey, 1992), suggests that a combination of historical and local factors have played a significant role in determining their current areas of occupancy. Each species may predate the Pleistocene fragmentation of rainforest habitats during the aridity events in Australia and be more consistent with the model proposed by Joseph et al. (1995) where Miocene/Eocene divergence dates were prevalent amongst several widely distributed but relatively immobile vertebrate species.

REMARKS. The diagnosis given above is slightly modified from Harvey (1992) and Reddell & Cokendolpher (1995), as two of the species described below, *N. spec* and *N. bronwenae*, possess accessory teeth on the movable cheliceral finger, a feature which was postulated by Harvey (1992) to be absent from all members of the genus. These two species are clearly good members of *Notozomus* as they share the spermathecal morphology characteristic of the genus and a 4-segmented female flagellum. The two species which possess an accessory tooth may represent the most plesiomorphic species of the genus, with those species which lack a tooth representing an apomorphic sister-group. However, further work on the phylogeny of the genus is not possible at present without access to further specimens and a better understanding of the relationships of genera within the Hubbardiinae.

Notozomus daviesae Harvey, 1992
(Fig. 1)

Notozomus daviesae Harvey, 1992: 114-116, figs 2, 110-114; Reddell & Cokendolpher, 1995: 84.

DIAGNOSIS. Males most closely resemble those of *N. bronwenae*, but differ in the shape of the dorsal depression of the male flagellum, and *N. daviesae* lacks an accessory tooth on the cheliceral finger. Females unknown.

REMARKS. This species is known from two males taken at Mt Finlay (Harvey, 1992).

Notozomus wudjl sp. nov.
(Figs 1, 2)

ETYMOLOGY. The specific name is a noun in apposition taken from the type locality.

MATERIAL. QUEENSLAND: Holotype ♂, 14.4km N of Wudjl Wudjl, 15°52'S, 145°19'E, 4.xi.1991-20.vii.1992, pitfall trap, PL, RR, MS (QM S24593). OTHER MATERIAL (non-types). QUEENSLAND: 1 juvenile, same data as holotype (QM S52169).

DIAGNOSIS. Males differ by the transverse, sinuate anterior margin of the dorsal depression on the flagellum which, in lateral view, has a concave profile. Females unknown.

DESCRIPTION. *Adult Male*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum (Fig. 2): posterior margin gently rounded, lateral margins sinuate; with dorsal depression of which the anterior margin is transverse and sinuate; seta dm1 situated at base of stalk, dl1 in anterior half, dm4 slightly anterior to dl3, vm4 anterior to vl2 and slightly closer to vl1 than to vm4; 1.72 times longer than broad. Pedipalp: probably not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with; claw 0.44 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 5 smaller teeth between these, basal tooth with 1 small, blunt, lateral teeth, distal tooth without lateral teeth; brush at base of fixed finger composed of 11 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 3.25 times longer than wide.

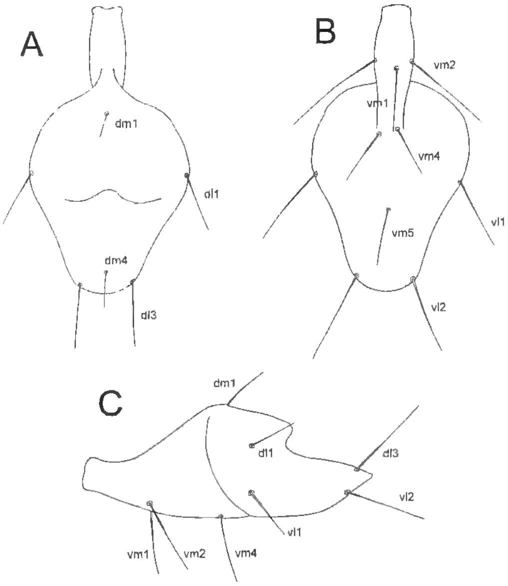

FIG. 2. *Notozomus wudjl* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral.

Dimensions (mm): Body length 4.32. Carapace 1.16/0.70. Chelicera 0.84. Flagellum 0.50/0.29. Pedipalp: TR 0.50, FE 0.52, PA 0.51, TI 0.49, TA 0.26, CL 0.12, total excluding CL 2.28. Leg I: TR 0.55, FE 1.45, PA 1.83, TI 1.33, ME 0.41, TA 0.67, total 6.24. Leg II: TR 0.24, FE 0.86, PA 0.55, TI 0.57, ME 0.46, TA 0.36, total 3.04. Leg III: TR 0.26, FE 0.73, PA 0.37, TI 0.41, ME 0.49, TA 0.38, total 2.64. Leg IV: TR 0.49, FE 1.30, PA 0.66, TI 0.94, ME 0.84, TA 0.64, total 4.87.

REMARKS. *Notozomus wudjl* is virtually sympatric with *N. daviesae* from nearby Mt Finlay which is only 4.1km from the type locality of *N. wudjl*. The two species differ in the morphology of the anterior margin of the dorsal depression of the male flagellum, which in *N. daviesae* is ∩-shaped, but in *N. wudjl* is transverse and sinuate.

Notozomus aterpes Harvey, 1992
(Fig. 1)

Notozomus aterpes Harvey, 1992: 112-114, figs 2, 5, 102-109; Reddell & Cokendolpher, 1995: 84, fig. 89.

NEW MATERIAL. QUEENSLAND: 1 ♀, Cape Tribulation National Pk, Cape Tribulation, 16°04'S, 145°28'E, sea level, sifting leaf litter in coastal forest, 24.vii.1992, C.E. Griswold (CAS).

DIAGNOSIS. Males differ by straight posterior margin of the flagellum. Females are the only species with both distal nodules on the spermathecal receptacula and large nodules on the ducts.

REMARKS. This specimen differs little from other females taken from the type locality (Harvey, 1992).

Notozomus majesticus sp. nov.
(Figs 1, 3)

ETYMOLOGY. Latin, *majestas* (majesty, greatness) referring to the imperial size and appearance of this species.

MATERIAL. QUEENSLAND: Holotype, ♂, SE. Windsor Tableland, 16°18'S, 145°05'E, 850m, 9.ii.-17.v.1998, intercept trap, GM, DC (QM S52170). Paratype: 1 ♀, Spencer Creek, Windsor Tableland, 16°16'S, 145°03'E, 1150m, 8.ii.1998, GM, DC (QM S52171).

DIAGNOSIS. Males differ in the position of flagellar seta dm1 which is situated midway between the flagellar stalk and the dorsal depression; they also have a unique lateral margin which is deeply incised. Females lack nodules on the spermathecal receptacula, and possess very sparse nodules on the ducts, thus resembling *N. monteithi* which, however, has more nodules on the ducts.

DESCRIPTION. *Adults*. Colour dark yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 (♂, ♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 (♂, ♀) setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum of ♂ (Fig. 3A-C) with deeply incised lateral margin and rounded posterior margin; seta dm1 situated midway between flagellar stalk and dorsal depression, dm4 situated on approximately same level as dl3, vm4 nearly on same level as vl1; 1.77 times longer than broad; flagellum of ♀ 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 3D): 4 spermathecae with rounded receptacula, without distal bifurcations or nodules; on slender, curved ducts originating near distal end of chitinised arch; ducts with sparse nodules; gonopod not bifurcate. Pedipalp: not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.31 (♂), 0.53 (♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 3 (♂) or 5 (♀) smaller teeth between these, basal tooth with 1 small, blunt, lateral teeth, distal tooth without lateral teeth; brush at base of fixed finger composed of 7 (♂) or 8 (♀) setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 (♂), 21 (♀) long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 3.40 (♂), 2.70 (♀) times longer than wide.

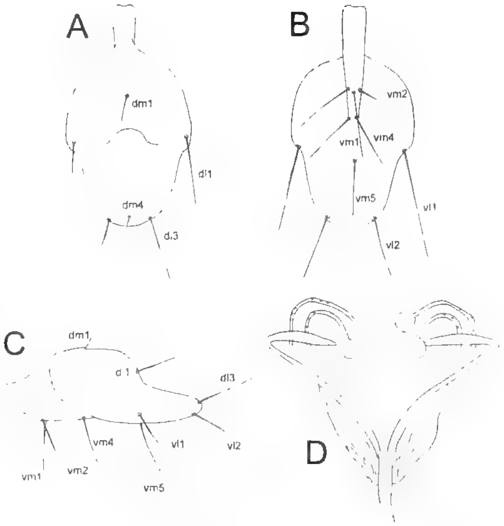

FIG. 3. *Notozomus majesticus* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral; D, ♀ genitalia, ventral.

Dimensions (mm), ♂ (♀): Body length 4.35 (4.25). Carapace 1.28/0.70 (1.38/0.84). Chelicera 0.83 (1.07). Flagellum 0.55/0.31 (0.44). Pedipalp: TR 0.44 (0.61), FE 0.48 (0.62), PA 0.47 (0.58), TI 0.46 (0.55), TA 0.26 (0.30), CL 0.08 (0.15), total excluding CL 2.11 (2.66). Leg I: TR 0.61 (0.49), FE 1.17 (1.32), PA 1.77 (1.60), TI 0.83 (1.19), ME 0.21 (0.41), TA 0.73 (0.58), total 5.32 (5.59). Leg II: TR

0.26 (0.20), FE 0.99 (0.96), PA 0.58 (0.55), TI 0.63 (0.61), ME 0.55 (0.50), TA 0.44 (0.44), total 3.45 (3.16). Leg III: TR 0.27 (0.28), FE 0.81 (0.86), PA 0.38 (0.43), TI 0.44 (0.44), ME 0.55 (0.55), TA 0.44 (0.46), total 2.89 (3.02). Leg IV: TR 0.49 (0.46), FE 1.48 (1.35), PA 0.60 (0.61), TI 1.10 (0.96), ME 0.97 (0.89), TA 0.67 (0.58), total 5.31 (4.85).

REMARKS. This species is known from only two specimens collected on the Windsor Tableland.

Notozomus monteithi Harvey, 1992
(Fig. 1)

Notozomus monteithi Harvey, 1992: 116-117, figs 2, 115-117; Reddell & Cokendolpher, 1995: 85.

DIAGNOSIS. Females resemble those of *N. rentzi* in the lack nodules on the spermathecal receptacula, but retain nodules on the ducts; those of *N. rentzi* possess numerous nodules, whereas those of *N. monteithi* have fewer. Males unknown.

REMARKS. This species is known only from Julatten (Harvey, 1992).

Notozomus maurophila sp. nov.
(Figs 1, 4)

ETYMOLOGY. Greek, *mauros* (dark) and *phila* (affection, fondness) referring to the presence of this species near Black Mt.

MATERIAL. QUEENSLAND: Holotype, ♂, Black Mt Rd, 5km N of Kuranda, 16°47'S, 145°38'E, 1200m, rainforest, sieved litter, berlesate, 2.xii.1988, GM, GT (QM S25823).

DIAGNOSIS. Males are similar to those of *N. daviesae* and *N. rentzi*, but *N. maurophila* differs in the presence of the anteriorly convergent dorsal depression on the male flagellum. Females unknown.

DESCRIPTION. *Adult Male*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum (Fig. 4): posterior margin gently rounded, lateral margins sinuate; with dorsal depression which converges anteriorly; seta dm1 situated at base of stalk, dl1 in posterior half, dm4 slightly anterior to dl3, vm4 anterior to vl2; 1.58 times longer than broad. Pedipalp: probably not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.53 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth, distal tooth without lateral tooth; brush at base of fixed finger composed of 8 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 16 long lamellae, blunt guard tooth present subdistally, accessory tooth absent near middle of file, but long low swelling present. Legs: tarsus I with 6 segments; femur IV 2.95 times longer than wide.

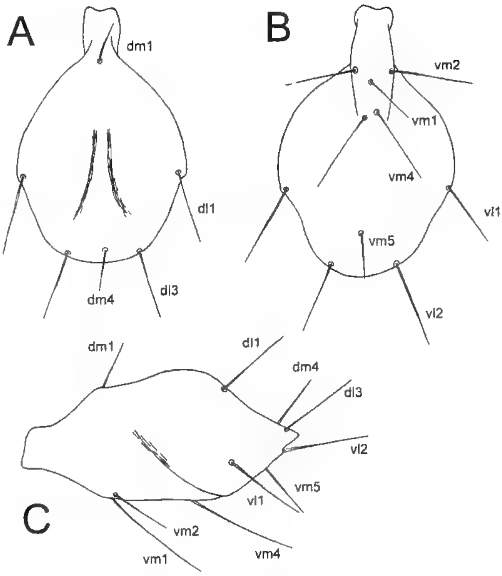

FIG. 4. *Notozomus maurophila* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral.

Dimensions (mm): Body length 3.58. Carapace 1.06/0.60. Chelicera 0.67. Flagellum 0.38/0.24. Pedipalp: TR 0.36, FE 0.44, PA 0.41, TI 0.39, TA 0.19, CL 0.10, total excluding CL 1.79. Leg I: TR 0.45, FE 1.31, PA 1.63, TI 1.19, ME 0.37, TA 0.56, total 5.51. Leg II: TR 0.20, FE 0.75, PA 0.46, TI 0.60, ME 0.44, TA 0.38, total 2.83. Leg III: TR 0.35, FE 0.67, PA 0.32, TI 0.37, ME 0.46, TA 0.38, total 2.55. Leg IV: TR 0.44, FE 1.15, PA 0.56, TI 0.90, ME 0.75, TA 0.53, total 4.33.

Notozomus elongatus sp. nov.
(Figs 1, 5)

ETYMOLOGY. Latin, *elongatus* (prolonged), referring to the shape of the spermathecal receptacula which are unusually long and slender.

MATERIAL. QUEENSLAND: Holotype, ♀, Mt Murray Prior, 16°56'S, 145°51'E, pyrethrum, trees, Casuarina, 7.xii.1998, GM (QM S49404).

DIAGNOSIS. Females of *N. elongatus* differ from those of other *Notozomus* species by the elongate spermathecal receptacula which are reflexed such that the apices are directed laterally. Males unknown.

DESCRIPTION. *Adult Female*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum of ♀ 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 5): 4 spermathecae with narrow, elongate receptacula, each deeply bifurcate with terminal nodules, receptacula reflexed such that apices are directed laterally; on slender, curved ducts originating near distal end of chitinised arch; ducts with sparse nodules; gonopod not bifurcate. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.45 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 5 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth, distal tooth without lateral teeth; brush at base of fixed finger composed of 8 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 21 long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 2.39 times longer than wide.

Dimensions (mm): Body length (slightly shrivelled) ca. 3.0. Carapace 1.04/0.64. Chelicera 0.84. Flagellum 0.35. Pedipalp: TR 0.41, FE 0.49, PA 0.46, TI 0.46, TA 0.27, CL 0.12, total excluding CL 2.09. Leg I: TR 0.35, FE 1.04, PA 1.26, TI 0.93, ME 0.32, TA 0.49, total 4.39. Leg II: TR 0.26, FE 0.78, PA 0.48, TI 0.48, ME 0.44, TA 0.35, total 2.79. Leg III: TR 0.22, FE 0.64, PA 0.34, TI 0.32, ME 0.44, TA 0.41, total 2.37. Leg IV: TR 0.38, FE 1.10, PA 0.50, TI 0.73, ME 0.69, TA 0.48, total 3.88.

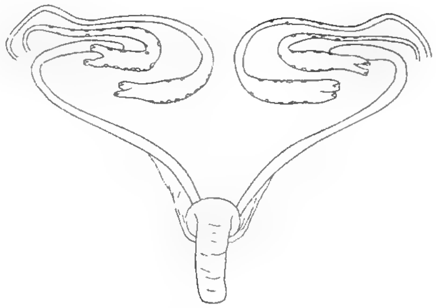

FIG. 5. *Notozomus elongatus* sp. nov., ♀ genitalia, ventral.

REMARKS. The spermathecal receptacula of most *Notozomus* species are spherical in shape, and the elongate receptacula of *N. elongatus* resemble only those of *N. aterpes*, from which it differs by the lack of nodules on the spermathecal ducts and by the greatly elongate receptacula.

It is possible that this species is the female of *N. maurophila*, which is known from a single male collected near Black Mt, some 30km to the northwest of Mt Murray Prior. I am reluctant to regard them as conspecific, as the fragmented speciation patterns evident in the genus (Fig. 1) call for caution prior to such an assumption. Therefore, I await the collection of further material to determine the status of these populations.

Notozomus rentzi Harvey, 1992
(Fig. 1)

Notozomus rentzi Harvey, 1992: 117-119, figs 2, 118-125; Reddell & Cokendolpher, 1995: 85.

DIAGNOSIS. Males differ by the presence of a dorsal depression in the flagellum which, in lateral view, forms a 90° angle. Females differ by the presence of numerous, contiguous, lateral ducts on the spermathecal ducts.

REMARKS. This species occurs over a wide region of the Atherton Tableland, extending as far east as Bellenden Ker NP (Harvey, 1992).

Notozomus ker Harvey, 1992
(Fig. 1)

Notozomus ker Harvey, 1992: 119-121, figs 2, 126-133; Reddell & Cokendolpher, 1995: 84.

DIAGNOSIS. Males differ by the presence of a distinct sub-rectangular depression on the flagellum, and by the position of seta vm4, which is on the same level as vl1. Females differ by the presence of only a few small nodules on the distal portion of the spermathecal ducts.

REMARKS. This species is known only from Cableway Base Station, Bellenden Ker Range, where it is virtually sympatric with *N. rentzi* (Harvey, 1992).

Notozomus raveni Harvey, 1992
(Fig. 1)

Notozomus raveni Harvey, 1992: 121-122, figs 2, 134-138; Reddell & Cokendolpher, 1995: 85.

DIAGNOSIS. Females differ by the lack of nodules on both the spermathecal receptacula and the ducts. Males unknown.

REMARKS. This species is known only from Majors Mt (Harvey, 1992).

Notozomus curiosus sp. nov.
(Figs 1, 6)

ETYMOLOGY. Latin, *curiosus* (odd, strange), referring to the uncertain generic position of this unusual species.

MATERIAL. QUEENSLAND: Holotype, ♂, Mission Beach (S3), 17°50'S, 146°06'E, 10m, pitfall trap C3, 29.iv.-3.vi.1996, MC (QM S52172). Paratype: 1 ♂, Mission Beach (S2), 17°52'S, 146°05'E, 20m, pitfall trap A3, 29 January-4.iii.1996, MC (WAM 99/3113).

DIAGNOSIS. Males can be recognised by the protruding tip on the flagellum. Females unknown.

DESCRIPTION. *Adult Male*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 13 setae, including 2 sternapophysial setae; posterior sternum triangular, with 7 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum (Fig. 6) with gently rounded lateral margin and rounded posterior margin with protuding tip; seta dm1 situated at base of flagellar stalk, dm4 situated on same level as dl3, vm4 situated slightly posterior to level of vl1; 1.36 times longer than broad. Pedipalp: probably not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.48 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal and distal teeth without lateral teeth; brush at base of fixed finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 2.98 times longer than wide.

Dimensions (mm): Body length 3.95. Carapace 1.15/0.59. Chelicera 0.75. Flagellum 0.38/0.28. Pedipalp: TR 0.41, FE 0.49, PA 0.46, TI 0.44, TA 0.23, CL 0.11, total excluding CL 2.03. Leg I: TR 0.44, FE 1.41, PA 1.71, TI 1.24, ME 0.40, TA 0.55, total 5.75. Leg II: TR 0.25, FE 0.84, PA 0.51, TI 0.52, ME 0.46, TA 0.38, total 2.96. Leg III: TR 0.21, FE 0.73, PA 0.32, TI 0.38, ME 0.46, TA 0.35, total 2.45. Leg IV: TR 0.45, FE 1.28, PA 0.58, TI 0.93, ME 0.87, TA 0.51, total 4.62.

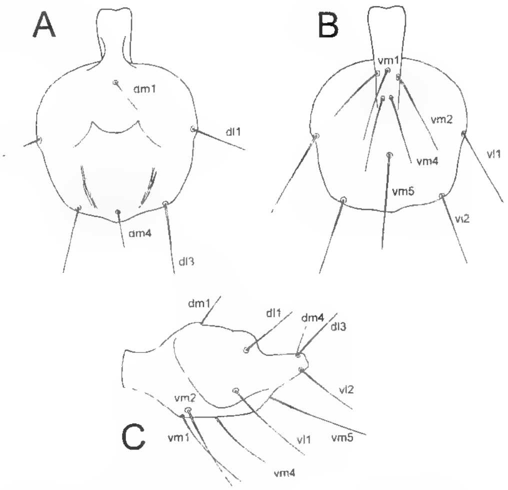

FIG. 6. *Notozomus curiosus* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral.

REMARKS. The morphology of the male flagellum is atypical for the genus, and the nature of the female spermathecae are necessary before the generic placement can be assured.

Notozomus ingham Harvey, 1992
(Figs 1, 7)

Notozomus ingham Harvey, 1992: 123-124, figs 2, 139-143; Reddell & Cokendolpher, 1995: 84.

NEW MATERIAL. QUEENSLAND: 1 ♂, Gayundah Creek, Hinchinbrook Island, 10m, 7-15.xi.1984, GM, DC, G Thompson (QM S52173); 1 ♀, Cardwell Range, Upper

Broadwater Valley, 18°18'S, 145°56'E, 750m, sieved litter, berlesate, 20.xii.1986, GM, GT, Hamlet (QM S25856).

DIAGNOSIS. The male flagellum lacks a distinct lateral profile, and setae dm4 and vm4 are distally situated, thus resembling *N. maurophila*, from which it differs by the ∩-shaped dorsal depression. Females differ by the possession of small distal nodules on the spermathecal receptacula and numerous nodules on the ducts which extend the full length of the ducts.

DESCRIPTION. *Adult Male.* Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum of ♂ (Fig. 7) with gently rounded lateral margin and rounded posterior margin; seta dm1 situated at base of flagellar stalk, dm4 situated slightly anterior to dl3, vm4 situated slightly anterior to level of vl2; 1.46 times longer than broad. Pedipalp: not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.43 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral teeth, distal tooth without lateral tooth; brush at base of fixed finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 2.98 times longer than wide.

Dimensions (mm): Body length 2.95. Carapace 0.99/0.55. Chelicera 0.70. Flagellum 0.38/0.26. Pedipalp: TR 0.40, FE 0.45, PA 0.43, TI 0.41, TA 0.21, CL 0.09, total excluding CL 1.90. Leg I: TR 0.41, FE 1.57, PA 1.57, TI 1.10, ME 0.35, TA 0.51, total 5.51. Leg II: TR 0.20, FE 0.83, PA 0.47, TI 0.51, ME 0.46, TA 0.38, total 2.85. Leg III: TR 0.20, FE 0.70, PA 0.32, TI 0.36, ME 0.47, TA 0.38, total 2.43. Leg IV: TR 0.37, FE 1.19, PA 0.58, TI 0.84, ME 0.78, TA 0.49, total 4.25.

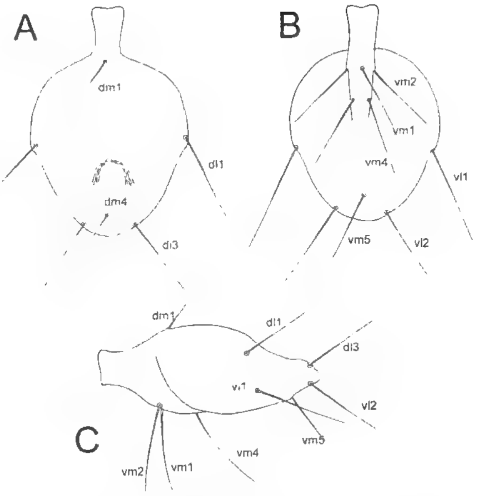

FIG. 7. *Notozomus ingham* Harvey, ♂ flagellum; A, dorsal; B, ventral; C, lateral.

REMARKS. The male from Hinchinbrook Island is the first male of this species to be described. Without males from the other localities from which this species has been reported, I cannot be certain that they all represent the same species. My suspicion that more than one species may be involved is fuelled by the large range exhibited by the species — no other species is known from such a broad zone — and that the rainforest patches are not continuous. The new female specimen from Cardwell Range differs little from other females of *N. ingham* recorded by Harvey (1992).

Notozomus spec (Harvey, 1992), comb. nov.
(Figs 1, 8)

Apozomus spec Harvey, 1992: 103-105, figs 2, 76-80; Reddell & Cokendolpher, 1995: 61.

NEW MATERIAL. QUEENSLAND: 1 ♀, Paluma, 19°01'S, 146°12'E, 6.v.1993, E.S. Volschenk, J. Saunders (QM S52174); 1 ♂, 7km NW of Paluma, 18°58'S, 146°09'E, under log in burnt forest, 20.iv.1993, MH, BS (WAM 99/3110); 1 ♂, Mt Spec, 19°00'S, 146°11'E, 875m, pitfall trap B1, 9.iii.-6.iv.1995, MC (WAM 99/3111); 1 ♂, same data except pitfall trap B2 (WAM 99/3112).

DIAGNOSIS. Males differ by positions of flagellar setae dm4 and vm4, which are situated midway between dl1 and dl3, and vl1 and vl2, respectively, and by the shape of the dorsal depression. Females differ by the possession of small distal nodules on the spermathecal receptacula and nodules on the ducts which extend only partway down the length of the ducts.

FIG. 8. *Notozomus spec* (Harvey); A, ♀ genitalia, ventral; B, left movable cheliceral finger.

DESCRIPTION. *Adult Female.* Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 8A): 4 spermathecae with rounded receptacula, each with a distal nodule; on slender, curved ducts originating near distal end of chitinised arch; ducts covered with sparse nodules; gonopod not bifurcate. Pedipalp: not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.39 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral teeth, distal tooth without lateral teeth; brush at base of fixed finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 16 long lamellae, blunt guard tooth present subdistally, accessory tooth, consisting of a long low mound, present near middle of file (Fig. 8B). Legs: tarsus I with 6 segments; femur IV 2.60 times longer than wide.

Dimensions (mm): Body length 4.15. Carapace 1.15/0.43. Chelicera 0.81. Flagellum 0.32. Pedipalp: TR 0.43, FE 0.33, PA 0.46, TI 0.44, TA 0.23, CL 0.09, total excluding CL 1.89. Leg I: TR 0.34, FE 1.01, PA 1.22, TI 0.64, ME 0.32, TA 0.44, total 3.97. Leg II: TR 0.23, FE 0.62, PA 0.54, TI 0.47, ME 0.40, TA 0.35, total 2.61. Leg III: TR 0.26, FE 0.70, PA 0.33, TI 0.36, ME 0.44, TA 0.35, total 2.44. Leg IV: TR 0.32, FE 1.12, PA 0.55, TI 0.78, ME 0.68, TA 0.45, total 3.90.

REMARKS. Harvey (1992) described *Apozomus spec* from a single male from Mt Spec, situated near Paluma, Queensland, and erroneously stated that the flagellum was 0.28mm in length and 0.20mm in width — in fact, the flagellum is 0.48 long and 0.40mm wide. The three new males listed above from Paluma and Mt Spec differ very little from the holotype, but the morphology of the female, newly recorded here from Paluma, shows the distinctive spermathecal morphology (Fig. 8A) characteristic of the genus *Notozomus*. The movable cheliceral finger bears a long low mound (Fig. 8B) situated near where a tooth is found in other genera, such as *Apozomus* (Harvey, 1992). The presence of this tooth led me to place this species in *Apozomus*. Females of *N. paluma* are most similar to *N. ker* Harvey from Bellenden Ker Range, Queensland, but differ in the presence of extremely small nodules on the spermathecal receptacula.

Notozomus bronwenae sp. nov.
(Figs 1, 9)

ETYMOLOGY. For Dr Bronwen Scott, who assisted in the collection of the type specimens.

MATERIAL EXAMINED. QUEENSLAND: Holotype, ♂, Wishing Pool, Eungella NP, 21°12'S, 148°32'E, from rotting log, 25.iv.1993, MH, BS (QM S52175). Paratype: 1 ♀, collected with holotype (QM S52176).

DIAGNOSIS. Males most closely resemble those of *N. daviesae*, but they differ in the shape of the dorsal depression of the male flagellum, and *N. bronwenae* possesses an accessory tooth on the cheliceral finger Females differ by the twisted spermathecal ducts.

DESCRIPTION. *Adults.* Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 15 (♂), 16 (♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 (♂, ♀) setae.

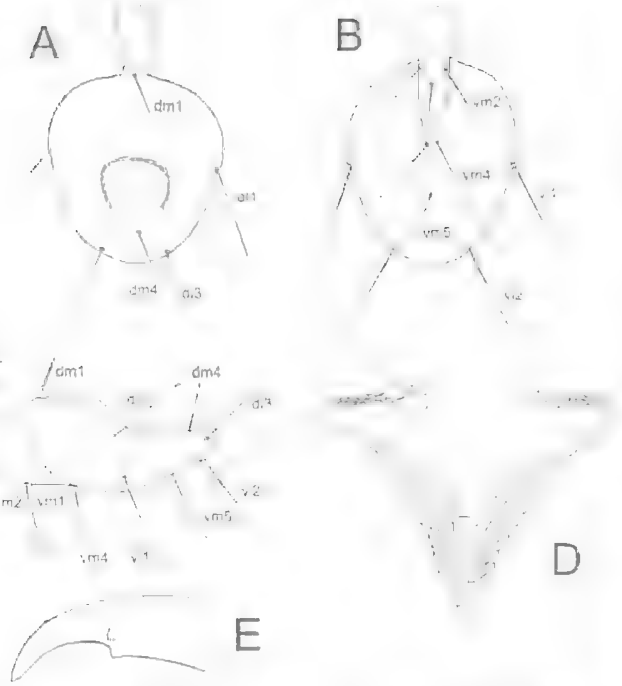

FIG. 9. *Notozomus bronwenae* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral; D, ♀ genitalia, ventral; E, left movable cheliceral finger.

Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum of ♂ (Fig. 9A-C) with gently rounded lateral margin and rounded posterior margin; seta dm1 situated at base of flagellar stalk, dm4 situated slightly anterior to dl3, vm4 midway between level of vl1 and vl2; 1.57 times longer than broad; flagellum of ♀ 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 9D): 4 spermatheeae with rounded receptacula, each with 2 terminal nodules; on slender, twisted ducts originating near distal end of chitinised arch; ducts with sparse nodules; gonopod not bifurcate. Pedipalp: not sexually dimorphic: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.44 (♂), 0.46 (♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 extremely small, blunt, lateral tooth, distal tooth of ♀ with 1 small, blunt, lateral tooth, of ♂ without lateral tooth; brush at base of fixed finger composed of 7 (♂), 8 (♀) setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 (♂), 17 (♀) long lamellae, blunt guard tooth present subdistally, accessory tooth present near middle of file (Fig. 9E). Legs: tarsus I with 6 segments; femur IV 2.93 (♂), 3.10 (♀) times longer than wide.

Dimensions (mm), ♂ (♀): Body length 4.05 (4.10). Carapace 1.16/0.56 (1.12/0.67). Chelicera 0.73 (0.86). Flagellum 0.44/0.28 (0.32). Pedipalp: TR 0.39 (0.41), FE 0.48 (0.49), PA 0.46 (0.47), TI 0.43 (0.44), TA 0.25 (0.26), CL 0.11 (0.12), total excluding CL 2.01 (2.07). Leg I: TR 0.35 (0.34), FE 1.28 (1.07), PA 1.58 (1.24), TI 1.19 (0.94), ME 0.38 (0.31), TA 0.61 (0.49), total 5.39 (4.39). Leg II: TR 0.21 (0.22), FE 0.82 (0.78), PA 0.49 (0.41), TI 0.53 (0.46), ME 0.45 (0.40), TA 0.38 (0.37), total 2.88 (2.64). Leg III: TR 0.23 (0.24), FE 0.72 (0.69), PA 0.35 (0.35), TI 0.39 (0.36), ME 0.47 (0.41), TA 0.40 (0.38), total 2.56 (2.43). Leg IV: TR 0.39 (0.36), FE 1.20 (1.10), PA 0.56 (0.52), TI 0.85 (0.77), ME 0.78 (0.68), TA 0.52 (0.48), total 4.30 (3.91).

REMARKS. *Notozomus bronwenae*, known only from Eungella National Park, differs from other species of the genus by the shape of the dorsal depression of the male flagellum, and the twisted spermathecal ducts. The morphology of the female genitalia is characteristic of the genus *Notozomus*, but the presence of an accessory tooth on the movable cheliceral finger is quite atypical, being found elsewhere in the genus only in *N. spec*, thus necessitating an alteration in the generic diagnosis presented by Harvey (1992) and Reddell & Cokendolpher (1995).

Notozomus jacquelinae sp. nov.
(Figs 1, 10)

ETYMOLOGY. This elegant species is named for the late Prof. Jacqueline Heurtault in recognition for her contributions to arachnology, whose untimely death occurred whilst I was midway through describing this species. I was fortunate to be able to call her a friend.

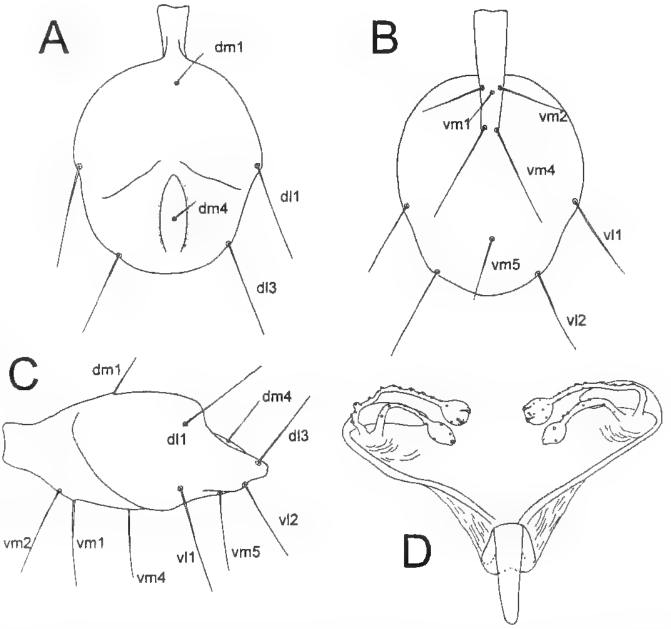

FIG. 10. *Notozomus jacquelinae* sp. nov., ♂ flagellum; A, dorsal; B, ventral; C, lateral; D, ♀ genitalia, ventral.

MATERIAL. QUEENSLAND: Holotype, ♂, Mt Abbot, RF (= rainforest) gully, 20°06’S, 147°45’E, 750m, pyrethrum, trees and rocks, 10.iv.1997, GM (QM S35340). Paratypes: 1 ♀, same data as holotype (QM S52177); 1 ♀, same data except leaf litter, 11.iv.1997 (QM S35341); 1 ♂, 3 ♀, 1 juvenile, Mt Abbot, 9-12.iv.1997, GM, DC, Janetzki (QM S35339); 1 ♀, same data (WAM 99/3114).

DIAGNOSIS. Males differ by the raised medial carina, which bears seta dm4. Females possess nodules on the spermathecal receptacula and the ducts.

DESCRIPTION. *Adults*. Colour dark yellow-brown, legs with a slight green hue. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 (♂), 13 (♀) setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 (♂, ♀) setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum of ♂ (Fig. 10A-C) with gently rounded lateral margin and rounded posterior margin, medially with raised carina which bears seta dm4; seta dm1 situated at base of flagellar stalk, dm4 situated slightly closer to level of dl3 than to dl2, vm4 midway between level of vl1 and vl2; 1.44 times longer than broad; flagellum of ♀ 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 10D): 4 spermathecae with ovoid receptacula, each with 2 distal nodules and small nodules on outer surface; on slender, curved ducts originating from chitinised arch; ducts covered with nodules, some of which protude from the surface of the duct; gonopod not bifurcate. Pedipalp: not sexually dimorphic; without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.40 (♂), 0.46 (♀) length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral tooth, distal tooth without lateral teeth; brush at base of fixed finger composed of 9 (♂), 8 (♀) setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 19 (♂), 18 (♀) long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 3.93 (♂), 3.68 (♀) times longer than wide.

Dimensions (mm), ♂ (♀): Body length 4.40 (4.50). Carapace 1.36 /0.70 (1.28/0.73). Chelicera 0.84 (0.92). Flagellum 0.49/0.34 (0.38). Pedipalp: TR 0.47 (0.49), FE 0.52 (0.53), PA 0.52 (0.52), TI 0.46 (0.49), TA 0.25 (0.26), CL 0.10 (0.12), total excluding CL 2.22 (2.29). Leg I: TR 0.63 (0.39), FE 1.89 (1.17), PA 2.41 (1.42), TI 1.78 (1.05), ME 0.54 (0.35), TA 0.70 (0.51), total 7.95 (4.89). Leg II: TR 0.24 (0.23), FE 1.08 (0.90), PA 0.60 (0.50), TI 0.73 (0.53), ME 0.60 (0.47), TA 0.44 (0.43), total 3.69 (3.06). Leg III: TR 0.27 (0.22), FE 0.92 (0.75), PA 0.44 (0.39), TI 0.51 (0.42), ME 0.61 (0.48), TA 0.45 (0.42), total 3.20 (2.68). Leg IV: TR 0.60 (0.42), FE 1.73 (1.25), PA 0.77 (0.58), TI 1.33 (0.90), ME 1.12 (0.78), TA 0.67 (0.52), total 6.22 (4.48).

REMARKS. This is one of the largest species of the genus, and is known only from Mt Abbot situated some 50km WSW of Bowen.

Notozomus faustus sp. nov.
(Figs 1, 11)

ETYMOLOGY. Latin, *faustus* (favourable, fortunate, lucky), referring to the luck involved in collecting this small species.

MATERIAL. QUEENSLAND: Holotype, ♀, Conway NP, 20°17'30"S, 148°46'20"E, eucalypt woodland, pitfall trap, 7.xi.1991–28.vii.1992, PL, RR, MS (QM S22766). OTHER MATERIAL (non-types). 1 juvenile, Conway National Park, 20°17'30"S, 148°46'15"E, eucalypt woodland, pitfall trap, 3.xii.1992–22.iv.1993, RR, S. Raven, PL & E. Lawless (QM S24596).

DIAGNOSIS. Females possess very few nodules on the spermathecal receptacula and the ducts. Males unknown.

DESCRIPTION. *Adult Female*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 11): 4 spermathecae with ovoid receptacula, each shallowly bifurcate, external pair with few nodules; on slender, curved ducts originating from chitinised arch; ducts sparsely covered with nodules; gonopod not bifurcate. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.43 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal tooth with 1 small, blunt, lateral teeth, distal tooth without lateral teeth; brush at base of fixed finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 18 long lamellae, blunt guard tooth present subdistally, accessory tooth absent. Legs: tarsus I with 6 segments; femur IV 2.57 times longer than wide.

Dimensions (mm): Body length ca. 3.4. Carapace 1.04/0.58. Chelicera 0.75. Flagellum 0.28. Pedipalp: TR 0.44, FE 0.46, PA 0.44, TI 0.41, TA 0.23, CL 0.10, total excluding CL 1.98. Leg I: TR 0.30, FE 0.90, PA 1.07, TI 0.83, ME 0.29, TA 0.42, total 3.81. Leg II: TR 0.21, FE 0.70, PA 0.41, TI 0.42, ME 0.35, TA 0.32, total 2.41. Leg III: TR 0.19, FE 0.58, PA 0.29, TI 0.31, ME 0.38, TA 0.32, total 2.07. Leg IV: TR 0.34, FE 0.97, PA 0.46, TI 0.67, ME 0.56, TA 0.40, total 3.40.

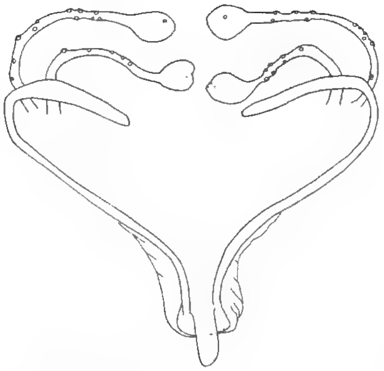

FIG. 11. *Notozomus faustus* sp. nov., ♀ genitalia, ventral.

REMARKS. The sole adult available for description is in poor condition through overclearing in the pitfall trap preservative. Nevertheless, it is clearly different from other members of the genus by the presence of only a few nodules on the spermathecal ducts, as well as nodules on the receptacula.

Notozomus boonah sp. nov.
(Figs 1, 12)

Apozomus woodwardi Harvey, 1992: 105-107 (misidentification, in part, specimen from near Boonah, Qld).

ETYMOLOGY. The specific name is a noun in apposition taken from the type locality.

MATERIAL. QUEENSLAND: Holotype, ♀, 16km N of Boonah (ca. 27°52'S, 152°41'E), ex leaf litter, 28.viii.1988, C. Burwell (QM ex-UQIC).

DIAGNOSIS. Females differ by the shape of the chitinised arch which forms a very narrow angle in mid-line. Males unknown.

DESCRIPTION. *Adult female*. Colour yellow-brown. Carapace with 9 setae, arranged 2: 1: 2: 2: 2; anterior margin drawn to a sharply downturned point between chelicerae; eye spots present. Mesopeltidia widely separated. Metapeltidium divided. Anterior sternum with 14 setae, including 2 sternapophysial setae; posterior sternum triangular, with 6 setae. Chaetotaxy of tergites I-IX: 2+4 (microsetae diagonal): 2+6 (microsetae in column): 2: 2: 2: 2: 2: 4: 4; tergite XII with very small dorsal process. Flagellum: 4 segmented, first segment slightly longer than second and third, fourth longest. Female genitalia (Fig. 12): 4 spermathecae with ovoid receptacula,

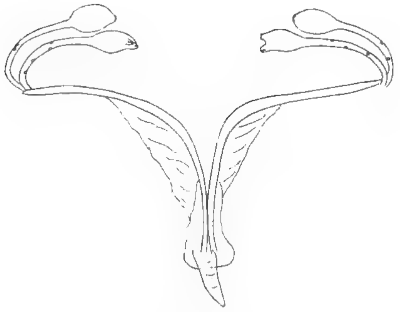

FIG. 12. *Notozomus boonah* sp. nov., ♀ genitalia, ventral.

each with 2 distal nodules, those on mesal pair forming large horns; on slender, curved ducts originating from chitinised arch, which form a very narrow angle in mid-line; ducts sparsely covered with nodules; gonopod not bifurcate. Pedipalp: without apophyses; trochanter without sharply produced distal extension, ventral margin with stout setae, with mesal spur; tibia and tarsus lacking spines; tarsus with spurs; claw 0.48 length of tarsus. Chelicera: fixed finger with 2 large teeth plus 4 smaller teeth between these, basal and lateral teeth each with 1 small, blunt, lateral tooth; brush at base of fixed finger composed of 7 setae, each densely pilose in distal half; lateral surface with 3 large, lanceolate, terminally pilose setae; movable finger file composed of 15 long lamellae, blunt guard tooth present subdistally, accessory tooth absent, but long, low flange present near middle of file. Legs: tarsus I with 6 segments; femur IV 2.50 times longer than wide.

Dimensions (mm): Body length 4.15. Carapace 1.09/0.64. Chelicera 0.73. Flagellum 0.28. Pedipalp: TR 0.38, FE 0.42, PA 0.41, TI 0.39, TA 0.23, CL 0.11, total excluding CL 1.83. Leg I: TR 0.32, FE 0.91, PA 1.39, TI 0.84, ME 0.29, TA 0.50, total 4.25. Leg II: TR 0.20, FE 0.65, PA 0.41, TI 0.44, ME 0.39, TA 0.32, total 2.41. Leg III: TR 0.20, FE 0.64, PA 0.32, TI 0.36, ME 0.38, TA 0.35, total 2.25. Leg IV: TR 0.35, FE 0.95, PA 0.48, TI 0.27, ME 0.61, TA 0.41, total 3.07.

REMARKS. The only known specimen of this enigmatic species was misidentified as *Apozomus woodwardi* by Harvey (1992), who did not dissect the female genitalia. Re-examination clearly shows that it is not conspecific with *A. woodwardi*, which has since been transferred to the genus *Brignolizomus* (Harvey, 2000), and it represents a species of *Notozomus*. It is by far the most southerly member of the genus *Notozomus*.

ACKNOWLEDGEMENTS

Specimens forming the basis of this revision were very kindly supplied by Robert Raven, Phil Lawless and Geoff Monteith (Queensland Museum), Charles Griswold (California Academy of Sciences), David Walter and Greg Daniels (University of Queensland), and Erich Volschenk (Curtin University of Technology, Perth).

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NEW STEREOMERINI AND RHYPARINI FROM AUSTRALIA, BORNEO AND FIJI (COLEOPTERA: SCARABAEIDAE: APHODIINAE)

H.F. HOWDEN AND R.I. STOREY

Howden, H.F. & Storey, R.I. 2000 12 31: New Stereomerini and Rhyparini from Australia, Borneo and Fiji (Coleoptera: Scarabaeidae: Aphodiinae). *Memoirs of the Queensland Museum* **46**(1): 175-182. Brisbane. ISSN 0079-8835.

Daintreecola grovei gen. nov., sp. nov. (Stereomerini) from Queensland, Australia, *Bruneixenus reidi* sp. nov. (Stereomerini) from Borneo and *Monteitheolus fijiensis* gen. nov., sp. nov. (Rhyparini) from Vanua Levu, Fiji, are described and illustrated. New Australian locality records for *Australoxenella concinna* Storey & Howden are also given. ☐ *Taxonomy, Australia, Fiji, Borneo, Daintreecola, Bruneixenus Monteitheolus, Scarabaeidae, Aphodiinae.*

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Since our paper establishing separate tribes for the Rhyparini and Stereomerini (Howden & Storey, 1992), 4 new genera and 14 new species in both tribes have been described (Bordat & Howden, 1995; Howden, 1995; Storey & Howden, 1996). In this paper we describe a new genus and species of Stereomerini from Australia, a new species of *Bruneixenus* Howden & Storey (Stereomerini) from Borneo, and a new genus and species of Rhyparini from Fiji. New Australian locality records for *Australoxenella concinna* Storey & Howden (Stereomerini) are also given.

Abbreviations used for collection names are: ANIC, Australian National Insect Collection, CSIRO, Canberra, Australia; HAHC, Collection of H.F. & A. Howden, Ottawa, Canada; QM, Queensland Museum, Brisbane, Australia; QPIM, Queensland Department of Primary Industries, Mareeba, Australia.

Family SCARABAEIDAE
Subfamily APHODIINAE
Tribe STEREOMERINI

Six genera placed in the tribe Stereomerini have been described from the Indo-Pacific region: *Adebrattia* Bordat & Howden, *Australoxenella* Howden & Storey, *Bruneixenus* Howden & Storey, *Danielssonia* Bordat & Howden, *Pseudostereomera* Bordat & Howden, and *Stereomera* Arrow. These genera are endemic to Australia (*Australoxenella*), Borneo (*Adebrattia*, *Bruneixenus*, *Danielssonia* and *Pseudostereomera*) and Singapore (*Stereomera*). A second Australian genus with one included new species is described below.

Daintreecola gen. nov.
(Fig. 1A-D)

TYPE SPECIES. *Daintreecola grovei* sp. nov.

ETYMOLOGY. Named after the Daintree area where specimens were collected.

DESCRIPTION. *Head* (Fig. 1A,B). Dorsally broad, flattened, feebly convex, about 1.6 × as wide as long. Clypeus anteriorly with very slightly inflexed edge, edge obtusely angulate medially and nitid. Head dorsally with distinct longitudinal median and lateral grooves, length of median groove about 1/2 dorsal length of head, groove deeper and broader in basal half, lateral grooves slightly deeper, about 2/5 of distance to outer edge of gena, lateral grooves not quite reaching base of head, lateral grooves distinctly sinuate; surface of head dorsally, except for grooves, with close, scale-like setae. Genae not obviously delimited, inner edge indicated by small, non-granulate markings near summit of convex area. Disc with short stria-like markings on lateral margins just in front of genal angles. Antenna 9-segmented, club 3-segmented, club equal in length to basal 6 segments of antenna combined; area surrounding antenna deeply concave. Eyes not visible dorsally, small, approximately 10 facets long by 14 wide, covered by pronotum when head retracted. Maxillary palpus 4-segmented, apical segment cylindrical.

Pronotum (Fig. 1B). Strongly, irregularly convex with moderately deep transverse sulcus, middle of sulcus positioned in centre of disc, the apices more anterior (about half distance to anterior pronotal margin) reaching lateral thirds of disc;

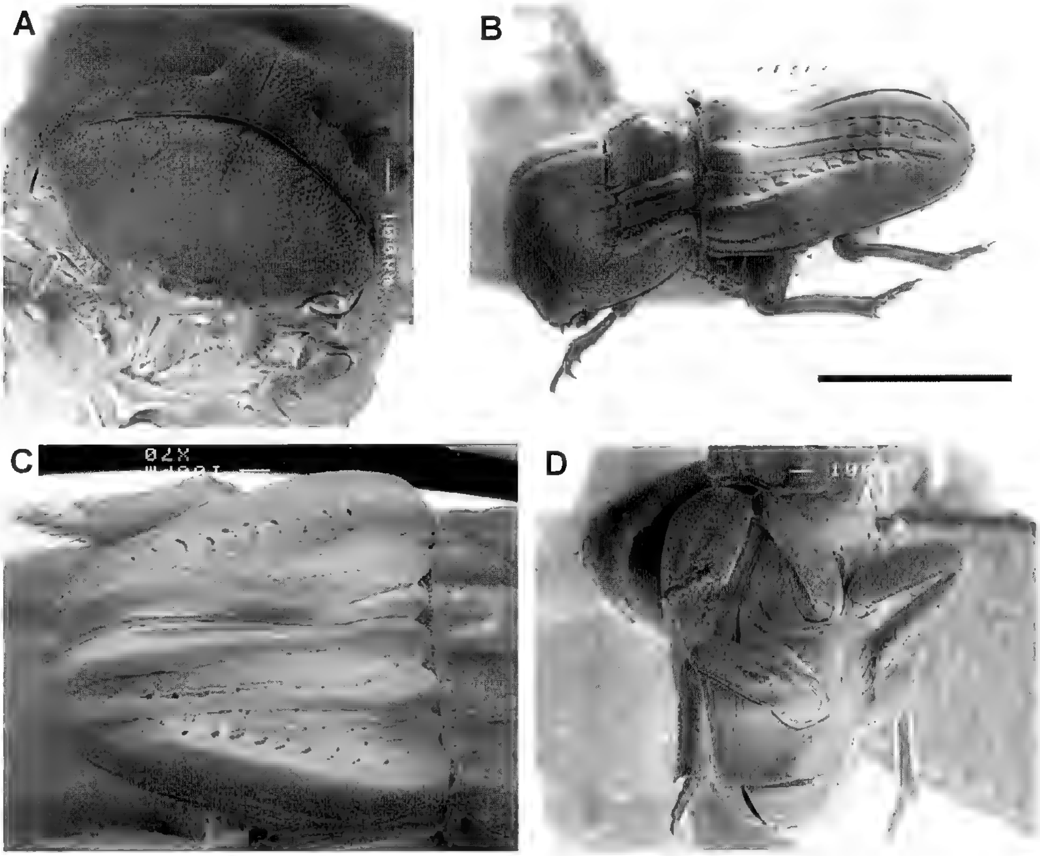

FIG. 1. *Daintreeola grovei* gen. et sp. nov. A, head, dorsal view; B, dorsolateral view; C, elytra, dorsal view; D, ventral view.

area anterior to sulcus with seven longitudinal grooves, all but central groove deepest posteriorly near sulcus; distinct groove running laterally along anterior pronotal margin from apex of outermost longitudinal groove to anterior angle then posteriorly along lateral margin to about 3/4 distance to posterior margin; rounded ridges (costae) between longitudinal grooves variable, inner two ridges strongly elevated and forming rounded prominence just anterior to transverse sulcus, outer 4 ridges slightly convex; equivalent median surface posterior to sulcus also with seven longitudinal grooves, median groove and associated ridges strongly convex and more strongly elevated than any other part of dorsum; three lateral posterior grooves on each side extending from pronotal base to sulcus, inner pair widest, especially in posterior half, outer two pairs deepest; ridges between grooves 2 and 3 and between 3 and 4 distinctly convex, ridge between grooves 3 and 4 flattened, ridge 4 located outside of groove 4 running from pronotal base to sulcus; lateral margins of pronotum slightly convex; anterior angles quadrate, posterior angles slightly obtuse, abruptly rounded; pronotal surfaces with close, appressed, scale-like setae, except grooves and sulcus, somewhat obscured in centre of disc. Scutellum not visible.

Elytron (Figs 1B-C). Disc with 8 distinct striae, these variable in length and impression, innermost stria feeble, partially effaced, almost impunctate; striae 2, 3 and 4 moderately to strongly impressed, about 4/5 length of elytron (can vary between left and right elytron in same individual), each with 1-6 deep punctures plus additional shallow ones; striae 5 and 6 short about 1/5 length of elytron, with a few indistinct punctures; row of about 12 large deep crescent-shaped punctures outside stria 6; striae 7 and 8 about 3/4 length of elytron, 7 more pronounced with distinct punctures, 8 feeble with no distinct punctures. Basal margin strongly incised, innermost incision between elytra deepest, incision 2 near base of stria 2 slightly smaller, incisions 3 and 4 at bases of striae 5 and 6 smallest; outer anterior angles rounded, subquadrate. Sections of disc strongly elevated, namely: interval 1 from basal quarter rising to maximal height about 2/3 distance to apex, height reduced just before apex; basal 1/5 of intervals 1, 3 and 5; outside crescent-shaped punctures from base to 4/5 distance to apex. Epipleura not inflexed, subvertical, narrowing to point at elytral apex, anterior 1/3 with groove on outer edge, widest anteriorly, ridge on inner edge, most prominent posteriorly, concave near middle, posterior 2/3 with lateral and central grooves running 4/5 distance to apex. Elytral apices conjointly broadly rounded. Surface covered by close, appressed, circular scales, density variable, largely effaced on intervals 2, 4, 5 and 6; surface dull, alutaceous.

Pygidium (Fig. 1D). Surface almost vertical, wider than long, with broadly rounded apex; numerous distinct medium-sized punctures.

Ventral surface (Fig. 1D). Prosternum laterally with surface alutaceous; median prosternal process anteriorly strongly elevated, narrow, process posteriorly lanceolate, medially carinate, with obtusely angled sides. Mesosternum moderate in size, subtriangular, narrowed laterally. Metasternum between mesocoxae narrow, blade-like, posterior to mesocoxae abruptly widened, flat, concave in posterior median 1/2 with shallow groove to posterior margin, anteriorly behind mesocoxae with transverse marginal groove which almost reaches lateral margin; metacoxae contiguous. Abdomen with 5 segments visible medially, 6 visible laterally, apical segment slightly shorter in midline than other segments combined, surface alutaceous to subnitid.

Legs (Fig. 1D). Femora about 3 to 4 times as long as wide. Protibia with 2 teeth on outer edge, one apical, 1 subapical. Meso- and metatibiae not flattened, approximately four times as long as wide; outer narrow edge of each tibia with irregular longitudinal rows of punctures, each puncture with a minute yellowish seta; each tibia with 2 small apical spurs, may be large setae; a few apical setae also present. Protarsus 5-segmented. Meso -and metatarsi 4-segmented, basal segment slightly shorter than second segment. Tarsal claws reduced in thickness.

REMARKS. *Daintreeola* can easily be separated from the only other Australian stereomerine genus *Australoxenella* by: lateral grooves on vertex of head distinctly 'S' shaped, acute anterior edge of clypeus not vertical, in same plane as clypeal disc; elytra distinctly laterally compressed, not dorsoventrally flattened; vertical sides of elytra wide, narrowed posteriorly; elytra bulbous anterior to apex, not flattened; meso- and metatibia oval in cross section, not flattened. Other differentiating characters are given in Table 1.

Daintreeola grovei sp. nov.
(Figs 1A-D)

ETYMOLOGY. For the collector, Simon Grove.

MATERIAL. Holotype, QMT93012: Australia: NE Qld, 16°06'31"S 145°26'25"E, Thompson Ck, 9.xi.-19.xii.1998, S. Grove, 140m, trunk FIT #4 (in QM). Paratypes (2): same locality and collector, 19.xii.1998-26.i.1999, trunk FIT #18 and #21 (In HAHC and QPIM).

DESCRIPTION (sex not determined). Length 2.3-2.6mm, greatest width 1.1-1.2mm. Colour light brown to brown. Morphology as in generic description and in Fig. 1A-D.

REMARKS. The three known specimens were taken by Simon Grove, of James Cook University in Cairns, in a long-term study of saproxylic insects in tropical rainforests in the Daintree lowlands of northeast Queensland. They were taken using trunk window traps, a relatively new sampling technique in Australia (Grove, 2000). Ground-based flight-intercept traps set nearby failed to collect this species, though several of another stereomerine, *Australoxenella concinna* Storey & Howden, were taken (see below).

RELATIONSHIPS. Howden & Storey (1992) described the genera *Australoxenella* and *Bruneixenus* and proposed the tribe Stereomerini within the Aphodiinae to contain them plus the previously described genera *Stereomera* and *Termitaxis* Krikken. Bordat & Howden (1995) added the genera *Adebrattia*, *Danielssonia* and *Pseudostereomera* to Stereomerini, removing the Neotropical genus *Termitaxis* until its unique type specimen could be closely examined. Howden & Storey (1992) undertook a cladistic analysis of the five stereomerine genera (including *Termitaxis*) available to them, using the tribe Eupariini (primarily *Ataenius* Harold) as the outgroup. Bordat & Howden (1995) repeated the analysis, removing *Termitaxis* and adding the three new genera described in their paper. Forty-five

TABLE 1. Phylogenetic characters in which *Australoxenella* and *Daintreeola* differ. P = plesiomorphic, A = apomorphic.

Character No.	Character	*Australoxenella*	*Daintreeola*
1	apical maxillary palpomere: cylindrical (P) or lanceolate (A)	P or A	P
2	pronotal trichomes absent (P) or present (A)	P or A	P
3	elytral apex unmodified (P) or flattened (A)	A	P
4	elytral striae distinct (P) or absent (A)	A	P
5	elytral striae punctate (P) or not (A)	A	P
6	sides of elytra parallel (P) or convergent (A)	P	A
7	elytral costae low (P) or high (A)	P	A
8	elytral epipleurae narrow (P) or wide (A)	A	P
9	pygidium vertical (P) or ventral (A)	A	P
10	metasternum feebly convex each side (P) or with marginal bead (A)	A	P
11	number of abdominal segments 5 (P) or 4 (A)	P or A	P
12	meso/metatibia cross section oval (P) or flattened (A)	A	P
13	sides of metasternum not rugose (P) or rugose (A)	A	P

phylogenetically important characters were used in these two studies. In this paper, the authors have rated *Daintreeola* using the combined character table of the Howden & Storey (1992) and Bordat & Howden (1995) papers. Table 1 lists only the characters in which *Daintreeola* and *Australoxenella* differ.

Australoxenella Howden & Storey, 1992

Australoxenella concinna
Storey & Howden, 1996

NEW RECORDS. 16°05'S 145°28'E, 2km SSW Cape Tribulation, CT2 10m, 4.i-1.ii.1996, L. Umback, FI Trap JCU (1); 16°01'S 145°27'E, Donovan Ck, 20m FIT DO5F, 14.iii-5.v.1998, S. Grove (1); same locality, 8.i.1998, S. Grove, mushroom bait trap (1); 16°06'31"S 145.26.25E, Thompson Ck, 140m Trunk FIT#4, 9.xi-19.xii.1998, S. Grove (1). (in ANIC, QPIM, HAHC, S. Grove, Cairns).

This species was described from a single specimen from a ground based flight intercept trap at 680m on the southern Atherton Tableland. All new records are from close to sea level in the Cape Tribulation area, 170km north of the type locality. One was taken in a pitfall trap baited with mushrooms and the others from flight intercept traps set on the ground or part way up tree trunks.

Bruneixenus Howden & Storey, 1992

Bruneixenus can be separated from the other genera of Stereomerini by the following combination of characters: large conical protrusion along pronotal midline anterior to median transverse sulcus; protrusion posterior to sulcus small, smaller than anterior protrusion; elytral disc with narrow costae or feebly raised intervals; elytra not abruptly declivous posteriorly; apex of each elytron rounded, not abruptly angulate near suture; tibiae only moderately flattened.

Bruneixenus reidi sp. nov.
(Fig. 2A-B)

ETYMOLOGY. Named for Dr Chris Reid, who collected the known specimens and recognised them as an unusual scarab.

MATERIAL. Holotype, ♀ (?), INDONESIA, Nanga Sg. Belabi, Sg. Sibau, Kalbar, 1°17'N, 113°15'E, 250-350m, rainforest on ridge, 5-8.vii.1996, C. Reid, yellow pan traps 10:1-10 (Museum Zoologicum Bogoriense, Bogor, Java, Indonesia). Paratype, same data as holotype (in HAHC).

DESCRIPTION. Length 1.8mm, greatest width 0.9mm. Reddish brown dorsally and ventrally.

Head (Fig. 2A-B). Dorsally broad, about 2 × as wide as long. Clypeus inflexed, forming broad, obtuse triangle, apex sharply angulate; base delimited by feebly indicated suture; clypeal surface evenly punctate, punctures small, surface between shining. Vertex very feebly, transversely concave in median 2/3, lacking tubercles; vertex with 5 narrow, longitudinal grooves, one median and two on each side equally spaced between centre and lateral edge, grooves anteriorly divergent; surface, except for grooves, with close, but not contiguous, appressed, oval scales. Gena not distinct, feebly ridged just anterior to eye, ridge abutting prothoracic edge. Antenna 9-segmented; club 3-segmented, densely setose, length slightly longer than basal six segments. Mouthparts and eyes as described for genus (Howden & Storey, 1992).

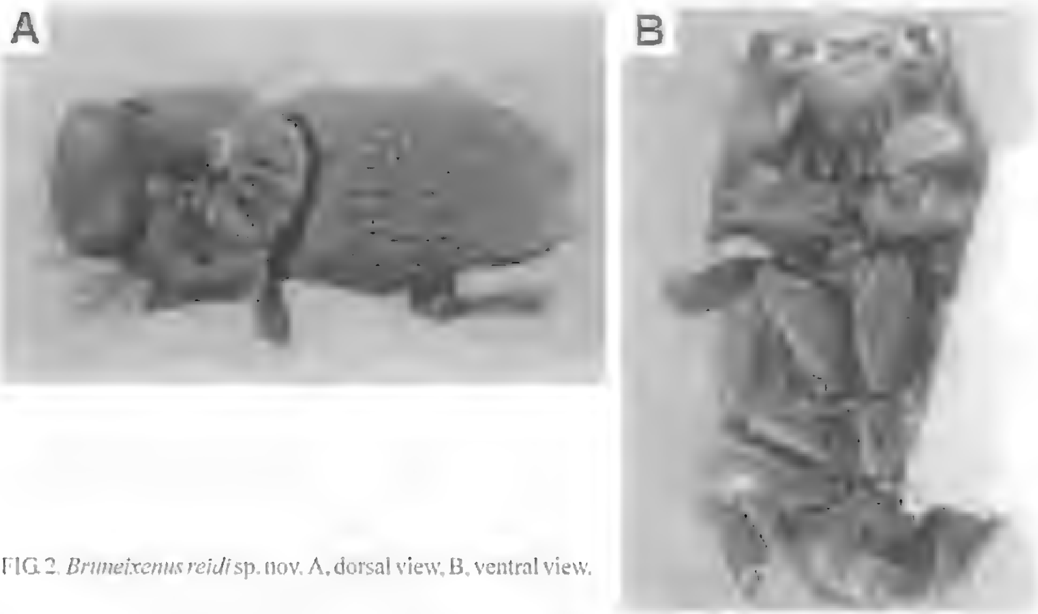

FIG. 2. *Bruneixenus reidi* sp. nov. A, dorsal view, B, ventral view.

Pronotum (Fig. 2A). Very irregularly convex with narrow transverse sulcus extending across median 1/3 near middle; median 1/5 of pronotum anterior to sulcus conical, delimited on each side by longitudinal groove; conical summit with two short spines, one on each side of midline, midline posterior to spines with groove extending to transverse sulcus. Each side of pronotum near outer 1/3 in anterior half with second groove converging posteriorly with inner groove; transverse sulcus continued laterally as deep groove curving posteriorly and ending in notch at lateral 1/3 of posterior pronotal margin; area adjacent and partly enclosed by groove depressed and almost flat; median 1/3 of pronotum posterior to transverse sulcus convex with seven longitudinal grooves, one median and three on each side, grooves on each side with scattered yellowish setae, grooves divergent posteriorly; convex ridge on each side of median groove with longitudinal row of four minute spines; most of pronotal surface with numerous stout, posteriorly directed, lanceolate setae. Scutellum minute, depressed below elytral surface.

Elytron (Fig. 2A). Nine striae present between suture and humeral angle, side of elytron abrupt; intervals of uniform height and same width as adjacent striae, crest flat, each with row of small, often indistinct, scales. Striae and intervals becoming confused in apical 1/3; side of elytron rounded, broadly inflexed, basal 1/3 with fine transverse striae; apex of each elytron rounded, very slightly reflexed posterior to termination of intervals.

Pygidium. Wider than long, feebly convex and inflexed; surface shallowly punctate, each puncture with an oval scale, surface between punctures shining.

Venter (Fig. 2B). Prosternum shining, slightly alutaceous; marginal bead present on each side adjacent to eye; median prosternal process anteriorly blade-like, apex slightly expanded; process posteriorly bluntly lanceolate. Metasternum with midline between meso- and metacoxae narrowly indented; transverse marginal bead present just posterior to mesocoxal depression; metasternal surface on either side of depressed midline nitid, punctate, each puncture with a small seta. Fifth sternite punctate, equal in length at midline to basal four segments. Protibia with two teeth on outer edge, one apical, one at apical 1/6. All tarsi apparently 5-segmented, legs otherwise as described for genus.

Variation. The single paratype measures: 1.7mm in length, 0.9mm in greatest width. Otherwise similar to holotype.

REMARKS. *Bruneixenus reidi* can be easily distinguished from the only other species in the genus, *B. squamosus* Howden and Storey, by its non-costate elytra. *B. squamosus* has four narrow, evenly elevated costae on each elytron.

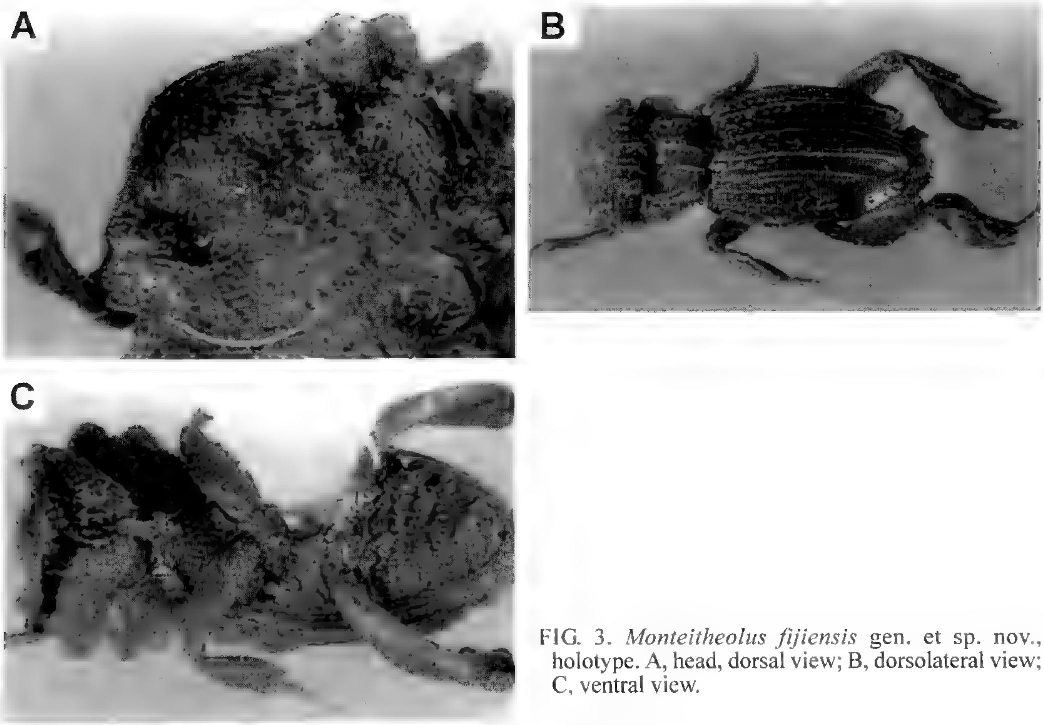

FIG. 3. *Monteitheolus fijiensis* gen. et sp. nov., holotype. A, head, dorsal view; B, dorsolateral view; C, ventral view.

The configuration of the pronotal grooves also differs between the two species.

Tribe RHYPARINI

Four genera have been recognised in the Rhyparini from the Australasian region (Howden, 1995): *Rhyparus* Westwood, *Termitodius* Wasmann, *Termitodiellus* Nakane, and *Hadrorhyparus* Howden. Recently a new genus and species was discovered on the eastern island of Vanua Levu, Fiji.

Monteitheolus gen. nov.
(Figs 3A-C, 4)

TYPE SPECIES. *Monteitheolus fijiensis* sp. nov.

ETYMOLOGY. Named for its energetic collector, Geoff Monteith, of the Queensland Museum.

DESCRIPTION. *Head* (Fig.3A). Approximately as wide as long; clypeal edge arcuate, narrow transverse section bordered posteriorly by raised arcuate ridge; section anterior to ridge depressed below plane of clypeo-frontal junction, not inflexed or toothed. Frontal area with broadly convex central disc; deep depression present on each side of disc; bottom of depression with what appears to be a number of eye facets. Gena with two strongly produced angulate lobes. Vertex posterior to disc with four longitudinal ridges, one on each side adjacent to midline, one on each side posterior to deep depression. Surface of disc and vertex shallowly punctate, most punctures each with a small, recumbent seta. Mouthparts and antennae hidden by legs.

Pronotum (Figs 3B, 4). Six strongly elevated, longitudinal ridges present on disc, ridges divided by transverse groove across middle of pronotum; ridges anterior to groove more elevated; three ridges on each side of midline anterior to groove evenly spaced; posterior to groove inner two pairs of ridges in longitudinal line with anterior ones, outer pair strongly flared laterad. Each side of pronotum with two lobes, one anterior, one posterior to line of transverse groove. Summits of all ridges bare, edged on each side by a row of pale setae, lateral pronotal margins also setose; pronotal surface between ridges alutaceous, uneven or tuberculate between median ridges. Ridges ending abruptly just before posterior margin, margin edged with narrow bead. Scutellum minute.

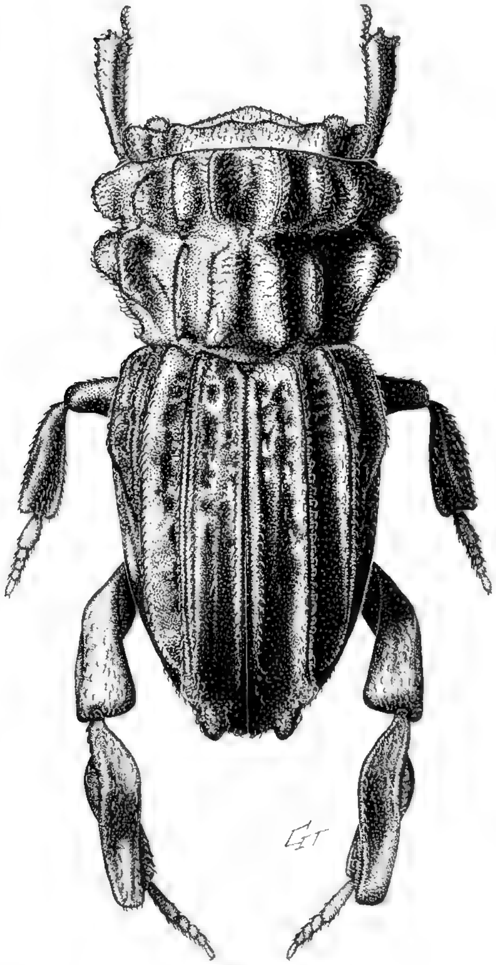

FIG. 4. *Monteitheolus fijiensis* gen. et sp. nov., holotype, dorsal view.

Elytron (Figs 3B, 4). Disc with 9 elevated intervals, length and height differing: intervals 1,3 and 4 extending to approximately apical 1/6 of elytron, 3rd and 4th intervals strongly elevated, more so apically and with apical end abruptly declivous, sutural interval low, these three intervals dorsally flattened, single row of setae present on laterad side of sutural interval, row on each side of intervals 3 and 4; interval 2 very low, summit rounded, uneven, with only scattered setae; intervals 5 to 7 short, extending only to basal 1/4 of elytron; summit of 6th interval flat, with row of setae on each side; intervals 5 and 7 low, summit narrow, irregular and with scattered setae; intervals 8 and 9 at side of elytron, both intervals extending to approximately apical 1/5 of elytron, height moderate with summit narrow, double rows of very small setae present on each. Surfaces between intervals with distinctly separated, large, shallow punctures, surface between shining. Elytron gradually narrowed in apical 1/2 (Fig. 4), apex abruptly rounded; irregular, raised, almost pyramidal knob present between apex and end of interval 3, projection with numerous curved setae, similar to those on end of interval 3.

Pygidium (Fig. 3C). Almost vertical in lateral view; slightly wider than long; median basal margin briefly indented, midline below to pygidial apex not depressed, surface on each side with large, transversely oval depression occupying about 2/3 of pygidial surface; surface finely, irregularly rugose.

Venter (Fig. 3C). Prosternum ridged anteriorly along midline, hastate posterior to coxae. Mesosternum feebly ridged adjacent to anterior edges of mesocoxae. Metasternum with elevated ridge between mesocoxae, posteriorly with median depression, widened at middle; surface on each side of depression slightly convex, heavily granulate; posterior and lateral margin adjacent to each mesocoxa strongly ridged, additional lateral ridge paralleling elytral margin; longitudinal depression present between ridge and edge of elytron (depression possibly for reception of inner edge of mesotibia). Abdomen (partly obscured by dirt and glue) apparently with five sternites; at least sternites 3 and 4 transversely convex, margins of segments 3, 4 and base of 5 transversely depressed and with deep oval depression on each side near lateral margin.

Legs (Figs 3B-C, 4). All femora punctate-setose on ventral surfaces, femora not unusually modified. Protibia with two adjacent teeth on outer apical edge; outer edge basad to teeth finely serrate. Mesotibia with outer edge very slightly sinuous. Metatibia (Figs 3C, 4) enlarged from near base to apex, outer and inner surfaces sinuous and slightly twisted, tibial apex with one minute spur and numerous, short, stout setae. Tarsi 5-segmented, meso- and metatarsi each with basal segment approximately as long as remaining four segments.

REMARKS. Two genera of Rhyparini are known from Fiji, *Monteitheolus* and *Hadrorhyparus*. Both share greatly modified metatibae. They also share some other characters, such as pronotal ridges, with the non-Fijian genera, *Termitodius* and *Termitodiellus*. *Monteitheolus* differs from all of these genera in having noticeable eye slits on the dorsum of the head, different placement of the elytral ridges, strong sculpturing of the mesosternum and abdominal sternites, and an oddly twisted, very characteristic c.u. metatibia.

Monteitheolus fijiensis sp. nov.
(Figs 3A-C, 4)

ETYMOLOGY. The species name is for its country of origin.

MATERIAL. Holotype, QMT46169, sex not determined, FIJI: 16°35'S 179°20'E, Vanua Levu: Mt Delaikoro, 21 July 1987, G. Monteith, QM. berlesate No.785, rainforest, 700m, sieved litter. (In QM).

DESCRIPTION. Length 2.6mm, greatest width of pronotum 1.25mm; length of elytra 1.6mm, greatest width 1.15mm. Dorsum light reddish brown, setae yellowish to tan. Other features as in generic description and Figs 3 and 4.

REMARKS. The small size and the sinuous, slightly twisted metatibia will separate *M. fijiensis* from any other known species in the Rhyparini.

ACKNOWLEDGEMENTS

We are greatly indebted to Simon Grove, James Cook University, Cairns, Geoff Monteith, Queensland Museum, Brisbane, and Chris Reid, Australian Museum, Sydney, for furnishing the highly unusual species that have formed the basis of this paper. We also thank Geoff Thompson, Queensland Museum, for the habitus drawing of *Monteitheolus fijiensis*. Henri Goulet, Research Branch, Agriculture Canada, Ottawa provided the photographs of *Bruneixenus reidi* and *Monteitheolus*. Anthony O'Toole, University of Queensland, Brisbane produced the SEMs of *Daintreeola grovei*. Anne Howden made helpful suggestions that improved the manuscript.

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A REVIEW OF THE DISTRIBUTION OF THE *POLYRHACHIS* AND *ECHINOPLA* ANTS OF THE QUEENSLAND WET TROPICS (HYMENOPTERA: FORMICIDAE: FORMICINAE)

RUDOLF J. KOHOUT

Kohout, R.J. 2000 12 31: A review of the distribution of the *Polyrhachis* and *Echinopla* ants of the Queensland Wet Tropics (Hymenoptera: Formicidae: Formicinae). *Memoirs of the Queensland Museum* **46**(1): 183-209. Brisbane. ISSN 0079-8835.

Ninety-one species of the genus *Polyrhachis* are recorded from the Queensland Wet Tropics. Fifty-nine of these represent previously described taxa and thirty-two are recognised as new. *Polyrhachis doddi* Donisthorpe is considered a junior synonym of *P. australis* Mayr and *P. yarrabahensis* Forel a junior synonym of *P. lombokensis* Emery. The genus *Echinopla* is represented by two species. Notes on synonymy and distribution are included. ❐ *Hymenoptera, Formicidae, Polyrhachis, Echinopla, Australia, North Queensland, Wet Tropics, systematics, synonymy, distribution.*

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received 20 March 2000.

Polyrhachis is one of the world's largest and most distinct genera of ants, occuring mostly in the tropics and subtropics of the Old World. In Australia, it is one of the most common, diverse and widespread ant genera with 109 described valid species and with at least as many undescribed (Kohout & Taylor, 1990; Kohout, 1994, 1998). In contrast, the related *Echinopla* is a small genus represented in Australia by only two valid described species (Taylor, 1992) with limited distributions along the eastern coast of northern Queensland, and with one species, outside the Wet Tropics, undescribed. Both genera are characterised by monomorphism and are distinguished from the closely related *Camponotus* and *Calomyrmex* by their large first gastral tergite which forms at least half of the length of the gaster. The mesosoma and petiole in *Polyrhachis* are usually armed with spines or teeth which, in *Echinopla*, are confined to the dorsum of the strongly transverse petiolar node (Bolton, 1994; Shattuck, 1999).

A variety of nests are constructed by *Polyrhachis* species. These may be subterranean (in burrows), terrestrial (beneath logs, stones etc.), lignicolous (in plant cavities) or arboreal (Hung, 1967). Kohout (1999) summarised the range of nest types used by Australian *Polyrhachis*. Many species have the ability to use larval silk to construct nests incorporating plant debris or leaves. Hölldobler & Wilson (1990) discussed the significance of *Polyrhachis* nest behaviour in the evolution of silken nests in ants. Several nests of Wet Tropics species are shown in Fig. 3A-F.

The Wet Tropics World Heritage Area of North Queensland, Australia, stretches for about 450km along the coast between Cooktown (15°30'S) and Townsville (19°30'S). For the purposes of this paper I will follow Monteith (1995) and include Mt Elliot, a little beyond the southern boundary of the World Heritage Area proper. The Wet Tropics includes a complex series of subcoastal ranges and plateaus, with elevations often reaching 1,000-1,300m and attaining a maximum of 1,600m. The region enjoys a wet, tropical climate which, modified in parts by seasonal (monsoonal) and rainshadow effects, has induced a mosaic of tropical vegetation types ranging from fully developed rainforest to dry, open eucalypt woodlands. This small, but biologically diverse area harbours well over half of all known Australian species of *Polyrhachis* and *Echinopla*. These have been systematically collected at many localities over the last 20 years by the Queensland Museum and other institutions. This paper summarises those collections and lists 91 species of *Polyrhachis* and 2 of *Echinopla* from the area. Of these, 32 species are currently undescribed and 20 are endemic to the Wet Tropics.

Table 1 lists the species in their subgenera and summarises their distribution features including vegetation affinity, endemicity, altitudinal range, and geographic range both within the Wet Tropics and through a number of distributional zones outside the Wet Tropics.

SUBGENERIC SUMMARY. Nine subgenera of *Polyrhachis* occur in the Wet Tropics. These include all known Australian subgenera apart from the nominal subgenus *Polyrhachis* which is restricted to monsoonal rainforests on Cape York Peninsula, north of the 14°S parallel. The most speciose Wet Tropics subgenera are the more characteristic Australian subgenera, namely *Hagiomyrma*, *Hedomyrma* and *Chariomyrma*, closely followed by the subgenus *Cyrtomyrma*. The subgenera can be summarised as follows:

Campomyrma is best developed in the south and west of Australia and is poorly represented in the Wet Tropics with 11 species including 2 undescribed. Most are at their northern limit and most occur at higher elevations. Five are restricted to elevations above 750m and 4 show significant disjunctions to the south.

Chariomyrma is the least known Australian subgenus and has 22 species in the Wet Tropics, of which 9 are new. Most are ground nesting. Ten species are at their northern limits and 6 are endemics. Five are only found in lowlands and none are restricted to high elevations.

Cyrtomyrma are arboreal nesters which mostly occur in the lowlands. Of the 12 Wet Tropics species 4 are endemics, 4 are at their southern limit and 4 are at their northern limit. Their taxonomy is currently under review and 7 of the species are new.

Hagiomyrma includes mostly ground-nesting, open forest species. Of the 19 species present, 10 are undescribed. Most are at higher elevations.

Hedomyrma includes 20, mostly lignicolous, species of which 4 are undescribed and 5 are endemic. Ten are at their northern limits and 4 show significant disjunctions with southern populations. Most occur at moderate elevations.

The remaining 4 subgenera, *Myrma*, *Myrmatopa*, *Myrmhopla* and *Myrmothrinax* contain mostly lowland, arboreal-nesting, rainforest species shared with New Guinea. With just 7 species between them reported from the Wet Tropics they represent only a shadow of their actual diversity which is centred in the South East Asian tropical rainforests.

VEGETATION AFFILIATION. On the basis of collection records, species have been scored in Table 1 as being rainforest restricted (R), open forest restricted (O), occurring in both rainforest and open forest (B), or mangrove restricted (M). More than half (49) of all species are open forest specialists while 36 species are restricted to rainforest and only 5 utilise both environments. The tidal environment of Wet Tropics mangroves have been invaded by 3 species of *Polyrhachis*, viz. *P. (Chariomyrma) sokolova*, *P. (C.) constricta* and *P. (Hedomyrma) machaon*.

ALTITUDINAL RANGE. The species have been scored in Table 1 under three elevational categories: low (L), below 200m; medium (M), from 200m to 750m; high (H), above 750m. Two thirds (64) of all species occur in the lowlands and a similar number (61) occur at medium altitude, but there is a rapid diminution above 750m where only 27 occur. Twenty one species are restricted to lowlands while 11 (7 open forest and 4 rainforest species) are found only in uplands. Only *P. (Hagiomyrma)* '*Hagio* 04' and *P. (Hedomyrma) erato* attain the highest elevations available in the region (such as the summits of 1,330m Thornton Peak and/or 1,620m Mt Bartle Frere) and are clearly high altitude specialists.

ENDEMICITY. Of the 20 species which are endemic to the Wet Tropics zone, two thirds (13) are rainforest species, 6 are open forest species and 1 is found in both vegetations. This is a much higher proportion of rainforest species than in the overall fauna. Most endemics are rather widespread within the Wet Tropics area, an exception being *P. (Hedomyrma)* '*Hedo* 09' which is confined to Mt Elliot.

EXTRA-LIMITAL DISTRIBUTION. The distribution of the Wet Tropics species outside of the Wet Tropics area is shown in columns F-H and L-Q of Table 1. This information is summarised on the map in Fig. 1A. The strongest affiliation of the fauna is to the south with 50 species shared with Central Queensland and 28 shared with southeast Queensland. Only 30 are shared with Cape York Pen. which is immediately adjacent to the north. The 12 species shared with New Guinea are almost all lowland, rainforest species which extend no further south than the Wet Tropics.

DISJUNCT DISTRIBUTIONS. A striking component of the Wet Tropics *Polyrhachis* fauna is a group of species which are shared with areas further south but which have substantial disjunctions between the two populations. These are typically high altitude wet sclerophyll species within the Wet Tropics which occur at localities along the western fringe of the mountain massifs such as Windsor Tableland, Mt Spurgeon, Hann Tbld, Baldy Mt and Evelyn Tbld. Disjunctions are frequently of the order of 500-700km to the Eungella/Mackay district (e.g. *P. cedarensis*, *P. femorata*, *P. mjobergi and P. ornata*) but some

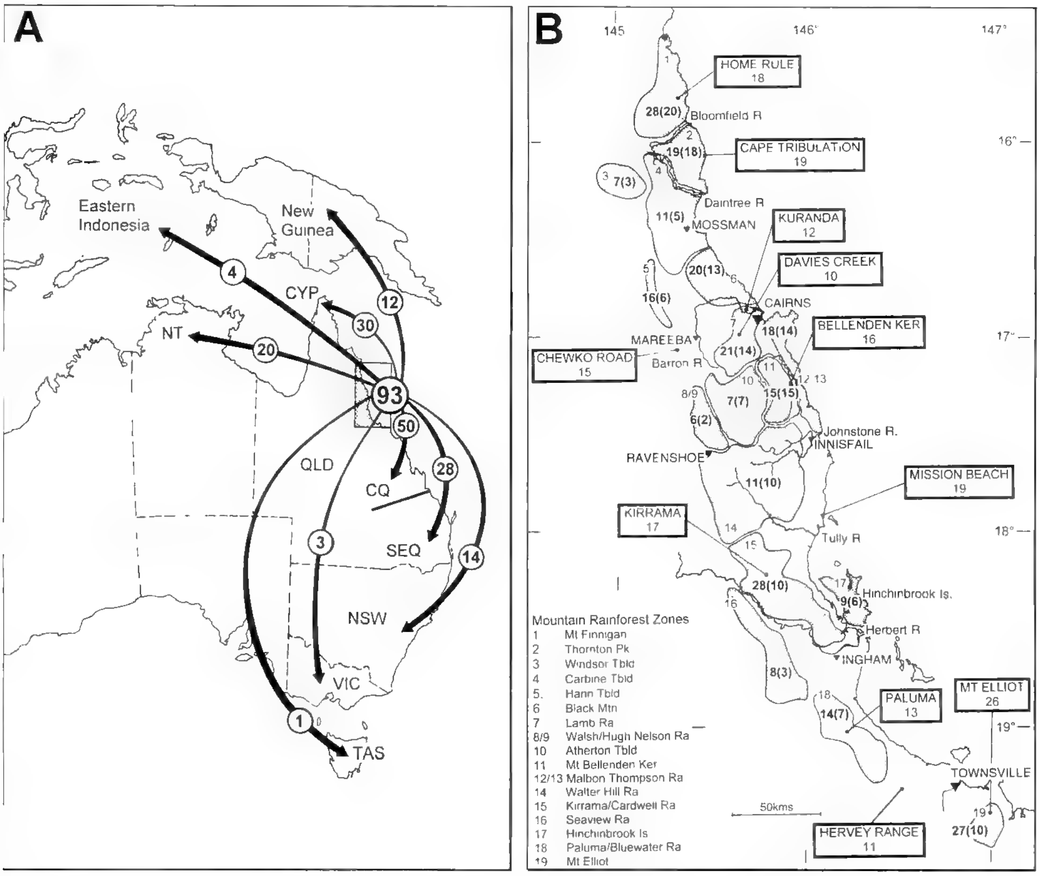

FIG. 1. A, Map of the Australian region showing location of Wet Tropics area (stippled). Numbers of species of *Polyrhachis* and *Echinopla* shared with adjacent land areas are indicated. B, Detailed map of the Wet Tropics area showing survey zones of mountain/rainforest tracts used. Numbers of recorded species of *Polyrhachis* and *Echinopla* are shown for each, with rainforest species in parentheses. Numbers of recorded species are also shown in boxes for several named sites where intensive collecting has taken place.

species have a greater disjunction of 950-1,200km to their nearest conspecific populations in southern Queensland (e.g. *P.* '*Campo* 02', *P.* '*Hagio* 18' and *P. rufifemur*). These disjunct distributions in ants clearly parallel similar disjunction in wet sclerophyll vertebrates such as the yellow-bellied glider (*Petaurus australis*) and the white-footed dunnart (*Sminthopsis leucopus*).

DISTRIBUTION WITHIN THE WET TROPICS. The Wet Tropics region is shown in Fig. 1B. The area has been divided arbitrarily into northern (north of Cairns), central (Cairns to Tully River) and southern (south of Tully River) sectors. It is also divided into the 17 mountain rainforest zones used by the Queensland Museum during survey collecting (Monteith, 1995). There has been reasonably thorough collecting of *Polyrhachis* within the region and it is unlikely that many more species will be discovered there. However it is clear that knowledge is still rather preliminary on the full distributions of species within the region. On a broad scale, totalling collecting records yields figures of 56 species (including 12 endemics) for the northern sector, 66 species (including15 endemics) for the central sector, and 64 species (including 13 endemics) for the southern sector. On a narrower scale the species numbers for each of the 17 survey zones are shown in Fig. 1B with maxima of 28, 28 and 27 species being achieved for Zones 1, 15, and 19, respectively. This does not accord with result totals for flightless Coleoptera and

TABLE 1. List of species of *Polyrhachis* and *Echinopla* recorded from the Wet Tropics region. Undescribed species are referred to by Voucher Codes as used in the Queensland Museum collection. Columns A-Q indicate distributional characteristics as follows: Column A: Vegetation Affiliation - R, rainforest only; O, open forest only; B, both rainforest and open forest; M, mangroves only. Column B: Endemicity - E, endemic (restricted) to the Wet Tropics. Columns C - E: Altitudinal Occurrence - C, below 200m (L); D, 200-750m (M); E, above 750m (H). Columns F-P: North/South Distribution where presence indicated by X - F, Indonesia; G, New Guinea; H, Cape York Peninsula, north of Cooktown; I, northern Wet Tropics (Cooktown to Barron River); J, mid Wet Tropics (Cairns to Tully); K, southern Wet Tropics (Tully to Mt Elliot); L, Central Queensland (Mt Elliot to Rockhampton); M, Southeast Queensland (south of Rockhampton); N, New South Wales; O, Victoria; P, Tasmania. Q, western distribution (Northern Territory) indicated by X.

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
P. (Campomyrma) cedarensis	O				H					X		X					
P. (Campomyrma) creusa	R		L	M			X	X	X		X	X					X
P. (Campomyrma) femorata	O				H				X	X		X	X	X	X	X	
P. (Campomyrma) flavibasis	R				H				X	X		X	X	X			
P. (Campomyrma) inconspicua	O		L					X	X	X	X	X					X
P. (Campomyrma) insularis	O		L	M			X	X	X	X		X	X				X
P. (Campomyrma) io																	
P. (Campomyrma) polymnia	R				H						X	X					
P. (Campomyrma) prometheus	O		L	M						X	X	X					X
P. (Campomyrma) ‘Campo 01’	O		L								X						X
P. (Campomyrma) ‘Campo 02’	O				H				X	X			X				
P. (Chariomyrma) constricta	M		L					X	X	X							X
P. (Chariomyrma) cyrus	O		L	M			X		X	X	X		X				
P. (Chariomyrma) gab	O		L	M				X	X	X	X						X
P. (Chariomyrma) heinlethii	O		L						X			X	X				
P. (Chariomyrma) hookeri																	
P. (Chariomyrma) lata	B		L	M	H			X	X	X	X	X	X				
P. (Chariomyrma) lownei	B			M	H				X	X	X	X					
P. (Chariomyrma) obscura	R			M							X	X					
P. (Chariomyrma) punctiventris	O		L	M	H						X	X	X				
P. (Chariomyrma) schoopae	R		L	M	H				X	X	X	X					
P. (Chariomyrma) senilis	O		L	M	H			X	X	X	X	X					X
P (Chariomyrma) sokolova	M		L			X	X	X	X		X	X					X
P. (Chariomyrma) vermiculosa	O		L								X	X	X	X			
P. (Chariomyrma) ‘Chario 01’	R	E		M	H				X	X	X						
P. (Chariomyrma) ‘Chario 04’	R	E	L						X	X	X						
P. (Chariomyrma) ‘Chario 05’	O		L	M						X	X	X	X				
P. (Chariomyrma) ‘Chario 06’	R	E		M	H				X	X							
P. (Chariomyrma) ‘Chario 08’	O		L	M					X		X	X					
P. (Chariomyrma) ‘Chario 10’	B	E	L	M					X	X	X						
P. (Chariomyrma) ‘Chario 11’	O			M						X		X	X				X
P. (Chariomyrma) ‘Chario 13’	O	E	L	M					X		X						
P. (Chariomyrma) ‘Chario 15’	O	E		M						X							
P. (Cyrtomyrma) australis	O		L	M							X	X	X	X			
P. (Cyrtomyrma) debilis	R		L	M	H		X		X	X							
P. (Cyrtomyrma) mackayi	O		L							X		X	X	X			
P. (Cyrtomyrma) pilosa	R			M							X	X	X	X			
P. (Cyrtomyrma) yorkana	R		L					X	X	X							
P. (Cyrtomyrma) ‘Cyrto 03’	R		L	M	H			X	X	X	X	X					
P. (Cyrtomyrma) ‘Cyrto 04’	R	E	L							X							
P. (Cyrtomyrma) ‘Cyrto 05’	R		L	M				X	X	X							
P. (Cyrtomyrma) ‘Cyrto 06’	R		L	M				X	X	X	X						
P. (Cyrtomyrma) ‘Cyrto 07’	R	E		M						X							

TABLE 1 *cont.*

Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
P. (Cyrtomyrma) 'Cyrto 08'	R	E	L	M					X	X							
P. (Cyrtomyrma) 'Cyrto 09'	R	E	L								X						
P. (Hagiomyrma) ammon	O			M	H				X	X	X	X	X	X	X		
P. (Hagiomyrma) crawleyi	O		L					X			X	X					X
P. (Hagiomyrma) lachesis	O		L	M				X	X	X	X	X					
P. (Hagiomyrma) lydiae	O		L	M							X	X	X	X			
P. (Hagiomyrma) penelope	O		L	M					X	X	X	X					
P. (Hagiomyrma) schenckii	O		L	M			X	X	X	X	X	X					X
P. (Hagiomyrma) thusnelda	O		L	M					X	X	X	X					
P. (Hagiomyrma) trapezoidea	O		L	M	H			X	X	X	X	X					X
P. (Hagiomyrma) tubifera	O		L	M	H			X	X	X	X	X	X				
P. (Hagiomyrma) 'Hagio 03'	O		L					X			X						X
P. (Hagiomyrma) 'Hagio 04'	R	E			H				X	X	X						
P. (Hagiomyrma) 'Hagio 10'	O		L					X	X	X	X						
P. (Hagiomyrma) 'Hagio 11'	O		L	M				X		X	X	X					X
P. (Hagiomyrma) 'Hagio 14'	O	E		M						X							
P. (Hagiomyrma) 'Hagio 16'	O			M							X	X					
P. (Hagiomyrma) 'Hagio 17'	O	E	L	M						X	X						
P. (Hagiomyrma) 'Hagio 18'	O				H				X				X				
P. (Hagiomyrma) 'Hagio 20'	O	E			H				X		X						
P. (Hagiomyrma) 'Hagio 21'																	
P. (Hedomyrma) argentosa	B		L	M	H				X	X	X	X					
P. (Hedomyrma) barretti	R		L	M				X	X	X	X						
P. (Hedomyrma) cleopatra	R			M							X	X					
P. (Hedomyrma) clio	R		L	M	H			X	X	X		X	X	X			X
P. (Hedomyrma) clotho	O		L					X			X	X					
P. (Hedomyrma) cupreata	B		L	M				X	X	X	X						X
P. (Hedomyrma) daemeli	O		L	M	H				X	X	X	X	X				
P. (Hedomyrma) erato	R				H					X		X	X				
P. (Hedomyrma) euterpe	O		L	M						X	X	X	X				
P. (Hedomyrma) hermione	R	E	L	M					X	X	X						
P. (Hedomyrma) machaon	M		L								X		X	X			
P. (Hedomyrma) mjobergi	O			M							X	X	X	X			
P. (Hedomyrma) ornata	O				H				X			X	X	X	X		
P. (Hedomyrma) rufifemur	O			M	H				X	X			X	X			
P. (Hedomyrma) thais	R	E	L	M					X	X	X						
P. (Hedomyrma) turneri	O		L	M				X	X	X	X	X					
P. (Hedomyrma) 'Hedo 05'	R			M					X	X	X	X	X				
P. (Hedomyrma) 'Hedo 07'	R	E	L	M					X	X							
P. (Hedomyrma) 'Hedo 09'	R	E		M							X						
P. (Hedomyrma) 'Hedo 13'	R	E	L	M					X	X	X						
P. (Myrma) foreli	R		L	M			X	X	X	X	X						
P. (Myrmatopa) lombokensis	R		L			X	X	X	X	X							
P. (Myrmhopla) dives	O		L			X	X			X							X
P. (Myrmhopla) mucronata	R		L			X	X	X	X	X	X						
P. (Myrmhopla) rustica	O			M						X		X					
P. (Myrmothrinax) delicata	R		L						X	X	X						X
P. (Myrmothrinax) queenslandica	R		L				X	X		X							
Echinopla australis	R		L				X	X	X	X	X	X					
Echinopla turneri	R		L								X	X					

Hemiptera for the same zones which yielded maxima for Zones 4, 7 and 11 (Monteith, 1995). However, Monteith included only rainforest taxa in that study. For *Polyrhachis* the inclusion of open forest elements obscures the rainforest pattern. The rainforest-only figures for *Polyrhachis* in the survey zones are shown in parentheses in Fig. 1B. The figures for *Polyrhachis* are probably also skewed because of high species numbers having been obtained from certain key localities where repeated collections have been made. Figures for these localities are entered on Fig. 1B. These maxima of 26 for Mt Elliot, 19 for Cape Tribulation, 18 for Home Rule, 15 for Chewko Road and 17 for Kirrama may be approaching complete lists for these particular sites because of the intensity of collecting undertaken.

METHODS

Synonyms of individual species are listed only where relevant to the context of this paper. For full synonymy citations see Bolton (1995), Dorow (1995) and Kohout (1998).

Unless otherwise indicated, all locality data listed below refer to the Queensland Wet Tropics area as delimited by Monteith, 1995 (see Fig. 1B). The numbering of voucher specimens representing new species (e.g. '*Campo* 01', '*Hedo* 05', etc.) corresponds with the system used in the *Polyrhachis* study collection in the Queensland Museum, Brisbane. Most of the material listed is lodged in the QMBA and/or ANIC collections.

Abbreviations. Collectors: CJB, C. J. Burwell; DJC, D. J. Cook; JPH, J. & P. Hasenpusch; HJ, H. A. Janetzki; RJK, R. J. Kohout; BBL, B. B. Lowery; GBM, G. B. Monteith; SKR, S. K. Robson; RWT, R. W. Taylor; GT, G. I. Thompson. Other abbreviations used in specimen data are: Bch, Beach; Ck, Creek; I., Island; JCU, James Cook University; NP, National Park; Pen., Peninsula; R., River; Ra., Range; Rd, Road; SF, State Forest; Tbld, Tableland; w, worker/s; Xing, Crossing.

Institutions (with the names of cooperating curators) are: ANIC, Australian National Insect Collection, Canberra, Australia (Drs S.O. Shattuck, R.W. Taylor); BMNH, The Natural History Museum, London, U.K. (Barry Bolton, C. Taylor); HNHM, Hungarian Natural History Museum, Budapest, Hungary (Dr J. Papp); MCSN, Museo Civico di Storia Naturale 'Giacomo Doria', Genoa, Italy (Drs R. Poggi, V. Raineri); MHNG, Muséum d'Histoire Naturelle, Geneva, Switzerland (Drs C. Besuchet, I. Löbl, B. Merz); MNHU, Museum für Naturkunde, Humboldt-Universität, Berlin, Germany (Dr F. Koch); MVMA, Museum of Victoria, Melbourne, Australia (Dr A. Neboiss); NHMB, Naturhistorisches Museum, Basel, Switzerland (Dr M. Brancucci); NHMW, Naturhistorisches Museum, Vienna, Austria (Drs M. Fischer, S. Schödl); NRMS, Naturhistoriska Riksmuseet, Stockholm, Sweden (Drs K-J. Hedqvist, F. Ronquist); OXUM, Hope Entomological Collections, University Museum, Oxford, U.K. (Dr C. O'Toole); QMBA, Queensland Museum, Brisbane, Australia (Drs C.J. Burwell, G.B. Monteith).

Genus **Polyrhachis** Fr. Smith, 1857
Subgenus **Campomyrma** Wheeler, 1911

Polyrhachis (Campomyrma) cedarensis
Forel, 1915

Polyrhachis (Campomyrma) leae r. *cedarensis* Forel, 1916: 114.

Polyrhachis cedarensis Forel; Kohout & Taylor, 1990: 511. Raised to species.

MATERIAL. Cedar Ck nr Ravenshoe (E. Mjöberg) (*leae cedarensis* syntype series MHNG) (w, ♀).

REMARKS. The syntypes are the only specimens of *P. cedarensis* I have seen from the Wet Tropics area. This species has also been collected from Eungella NP, Finch Hatton Gorge (RJK acc. 75.172/2).

Polyrhachis (Campomyrma) creusa
Emery, 1897
(Fig. 4A)

Polyrhachis creusa Emery, 1897: 577.

(For full synonymy citations see Kohout & Taylor, 1990: 514 and Kohout, 1998: 506).

MATERIAL. Mt Webb NP, 15°04'S, 145°07'E, 27-30.iv.1981 (J.E. Feehan) (w); Black Mtn Rd, nr Kuranda, 350m, 6-8.v.1961 (J.L.& M. Gressitt) (w); Kirrama, 30.iv.1989 & 4-10.iv.1993 (C.J. Hill) (w); Kirrama Ra., nr JCU Field Stn, 18°11'S, 145°44'E, c. 600m, 4.vi.1996 (RJK et al. acc. 96.15) (w).

REMARKS. *Polyrhachis creusa* is a ground-nesting species, predominantly in wet sclerophyll and rainforest. It ranges from the Bismarck Archipelago to northern Australia where it has been collected near Darwin in the Northern Territory and in Queensland from Cape York Pen. south to Mackay.

Polyrhachis (Campomyrma) femorata
Fr. Smith, 1858

Polyrhachis femoratus Fr. Smith, 1858: 73.

MATERIAL. Windsor Tbld, NW, 16°13'S, 144°59'E, 1100m, 23-24.xi.1997 (GBM, DJC & CJB) (w); Baldy Mt Rd, 17°20'S, 145°25'E, 1130m, 30.xi.1997-5.ii.1998 (GBM, DJC & CJB) (w).

REMARKS. *Polyrhachis femorata* extends from about Mackay south to Victoria and Tasmania with a single collection in South Western Australia (S.J. Curry). The two workers from Baldy Mt Rd and a single worker from Windsor Tbld are remarkably similar to the other available material, and represent an isolated, disjunct population of this southern species in high altitude wet sclerophyll habitat in the Wet Tropics. It is an inhabitant of open *Eucalyptus* forests or, less commonly, wet sclerophyll forests. It is a lignicolous species which favours hollow tree branches as nesting sites.

Polyrhachis (Campomyrma) flavibasis
Clark, 1930

Polyrhachis (Campomyrma) flavibasis Clark, 1930: 16.

MATERIAL. Windsor Tbld, 16°15'S, 145°02'E, 1060m, 8.ii.1998 (GBM & DJC) (w); Hann Tbld (Nth End), 16°49'S, 145°11'E, 950-1000m, 11-14.xii.1995 (GBM, GT & DJC) (w); Atherton Tbld, Yungaburra distr., Gadgarra SF, iv.1996 (A. Cutter & J. King) (w); Kenny Rd, 17°28'S, 145°32'E, 850m, 25.xi.1994-10.i.1995 (GBM & JPH) (w); Millaa Millaa Falls, 17°30'S, 145°37'E, 16.v.1995 (GBM) (w).

REMARKS. Originally described from Brooklana and Dorrigo on the northern NSW coast, *P. flavibasis* ranges northwards along the eastern slopes of the Great Dividing Range. It appears that the northern borders of the Wet Tropics are its northern limit. It is a rainforest dwelling species nesting in various plant cavities, such as hollow twigs and small tree branches.

Polyrhachis (Campomyrma) inconspicua
Emery, 1887

Polyrhachis inconspicua Emery, 1887: 225.
Polyrhachis thalia Forel, 1902: 530. Synonymy by Taylor, 1989: 24.

REMARKS. *Polyrhachis inconspicua* is a widespread species extending from Barrow I. in Western Australia, across the Northern Territory to Queensland where it has been collected from Torres Strait islands south to about Mackay. I have not seen any specimens of this species from the Wet Tropics area proper, however, Taylor (1989:24-25) lists its distribution from 1-degree grid cells 16/145, 17/145 and 18/146 which are all within the designated area.

Polyrhachis (Campomyrma) insularis
Emery, 1887

Polyrhachis inconspicua var. *insularis* Emery, 1887: 226.
Polyrhachis insularis Emery; Taylor, 1989: 25. Raised to species.

MATERIAL. Capt. Cook Hwy, c. 10km NW of Ellis Bch, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); Kamerunga, 10km NW of Cairns, 16°53'S, 145°41'E (ANIC coll.) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.44) (w).

REMARKS. This species ranges from New Guinea south to the Northern Territory and from Torres Strait islands and Cape York Pen. south to southern Queensland. It is a ground-nesting species restricted to open forests and woodlands.

Polyrhachis (Campomyrma) io
Forel, 1915

Polyrhachis (Campomyrma) thalia var. *io* Forel, 1915: 114.
Polyrhachis io Forel; Taylor, 1989: 25. Raised to species.

MATERIAL. Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.44) (w).

REMARKS. Two workers collected along Chewko Rd are the only known specimens of this rare species from Queensland. They match closely the vouchers of *P. io* in ANIC and QMBA (Katherine Gorge, NT, 12.vii.1986, A.N. Andersen). The type series was collected at Derby in north-western Australia by Eric Mjöberg. The only other records came more recently from Kununurra in Western Australia (J.D. Majer) and from Katherine Gorge in Northern Territory (BBL).

Polyrhachis (Campomyrma) polymnia
Forel, 1902

Polyrhachis polymnia Forel, 1902: 532.

MATERIAL. Mt Halifax, summit, 19°07'S, 146°23'E, 21.iii.-10.v.1991 (DJC) (w).

REMARKS. A single specimen is the only record of *P. polymnia* from the Wet Tropics. This rare species was originally described from Mackay and, besides the types, it is known from a few additional collections (Conway Ra., Brandy Ck Rd, RJK, and Cedar Ck Falls, 15km SE Proserpine, BBL). It is very similar to *P. maculata* Forel and their relationship was discussed by Taylor (1989: 25).

Polyrhachis (Campomyrma) prometheus Santschi, 1920

Polyrhachis (Campomyrma) prometheus Santschi, 1920: 566.

MATERIAL. Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.42) (w); Townsville (F.P. Dodd) (*prometheus* syntype series NHMB) (w); Townsville Field Traning area/Tabletop, 19°27'S, 146°24'E, ii.1999 (A. Ash #76) (w).

REMARKS. *Polyrhachis prometheus* is an uncommon, ground-nesting, species of open sclerophyll forests. It occurs patchily from Groote Eylandt in the Northern Territory to Croydon in the Queensland Gulf Country and from Mareeba south to Rundle Ra. near Gladstone.

Polyrhachis (Campomyrma) sp. ('*Campo* 01')

'*Polyrhachis (Campomyrma) micans* r. *ops* var. *rufa*' Crawley, 1921: 97.
'*Polyrhachis (Campomyrma) micans ops rufa*' Crawley; Taylor, 1986: 34. Unavailable name.

MATERIAL. Townsville, 11.xii.1902 (F.P. Dodd #203) (w of the original series in ANIC, BMNH and QMBA).

REMARKS. The original series of the quadrinominal infrasubspecies '*P. (Campomyrma) micans ops rufa*' was allegedly collected by F.P. Dodd at Townsville in the early 1900s. However, I have seen no specimens from elsewhere in Queensland. The only recent records of this rare species are from Nourlangie Rock, Kakadu NP (RJK) and Groote Eylandt (A.N. Andersen) in the Northern Territory. Since Dodd collected around Darwin himself in 1908/09 (Monteith, 1991) the Townsville record may be erroneous.

Polyrhachis (Campomyrma) sp. ('*Campo* 02')

MATERIAL. Windsor Tbld, NW, 16°13'S, 144°59'E, 1100m, 23-24.xi.1997 (GBM, DJC & CJB) (w); Mt Spurgeon, 4km NNE of Stewart Ck, 16°24'S, 145°13'E, 1250-1300m, 15-20.x.1991 (GBM, DJC, HJ & L. Roberts) (w); ditto, 1200-1250m, 17-19.x.1991 (ditto) (w); Carbine Tbld, 1330m, 27-28.xi.1990 (GBM, GT, DJC, R. Sheridan & HJ) (w); Tully, xi.1991 (P. Stumkat) (w).

REMARKS. This new species is intermediate between *P. femorata* Fr. Smith and *P. flavibasis* Clark. It is apparently an inhabitant of higher altitude, mostly wet sclerophyll forests, and has also been recorded from Dawes Ra., D'Aguilar Ra., Tamborine Mt. and Lamington NP in south-eastern Queensland. Its occurrence in the Wet Tropics is a disjunction of 900km from the southern localities.

Subgenus **Chariomyrma** Forel, 1915

Polyrhachis (Chariomyrma) constricta Emery, 1897

Polyrhachis constricta Emery, 1897: 584 (footnote).

MATERIAL. Low I., 16°23'S, 145°33'E, 14.viii.1954 (M.J. Mackerras & E.N. Marks) (w); Bellenden Ker (M. Podenzana) (*constricta* holotype w MCSN).

REMARKS. *Polyrhachis constricta* was described from a specimen collected at Bellenden Ker but, besides the holotype and a single specimen from each of Horn and Low Islands, I have not seen other specimens from Queensland. However, in recent years the species has been more frequently collected in the Northern Territory (A.N. Andersen, RJK). It closely resembles small specimens of *P. sokolova* (var. *degener*) and the two are sympatric in suitable localities in northern coastal mangrove forests.

Polyrhachis (Chariomyrma) cyrus Forel, 1901

Polyrhachis cyrus Forel, 1901a: 32.
Polyrhachis urania Forel, 1902: 516. Synonymy by Kohout, 1998: 511.

MATERIAL. Mt Molloy, 14.ix.1981 (BBL) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc. 2000.43) (w); Mt Elliot NP, 25.v.1980 (BBL) (w); Alligator Ck, Bowling Green Bay NP, 19°26'S, 146°57'E, 2.vi.1996 (RJK et al. acc. 96.9) (w).

REMARKS. The relationships of *P. cyrus* and its Australian form described by Forel in 1902 as *P. urania* was discussed by Kohout (1998:511). This is an uncommon species ranging from the Bismarck Archipelago and mainland Papua New Guinea to Queensland where it has been infrequently collected as far south as Fraser Island. It favours moist areas in open forests or rainforest edges. It nests in the ground with the entrance usually covered with a rock or piece of wood.

Polyrhachis (Chariomyrma) gab Forel, 1879

Polyrhachis guerini r. *gab* Forel, 1879: 116.
Polyrhachis gab Forel; Dalla Torre, 1893: 262. Raised to species.
(For full synonymy citations see Kohout, 1988a: 50 and Kohout & Taylor, 1990: 515).

MATERIAL. Hann Tbld (Nth Base), 16°48'S, 145°12'E, 500m, 11-14.xii.1995 (GBM, GT & DJC) (w); Granite Gorge, 17°02'S, 145°21'E, 450m, 26.xi.1997 (GBM, DJC & CJB) (w); Townsville, 13.viii.1944 (F.C. Bishop) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.ix.1977 (RJK acc. 77.8) (w).

REMARKS. *Polyrhachis gab* is the least common species of the *gab* species-complex. Its distribution extends across northern Australia from the Northern Territory to Queensland, where it is known from the Gulf Country and Cape York Pen. and as far south as Mt Elliot. It is predominantly a ground-nesting species, mostly in open sclerophyll forests and savannah woodlands. For comments on biology, distribution and synonymy see Kohout (1988a: 49-51).

Polyrhachis (Chariomyrma) heinlethii
Forel, 1895

Polyrhachis heinlethii Forel, 1895: 47.
Polyrhachis heinlethi var. *sophiae* Forel, 1902: 521. Synonymy by Kohout & Taylor, 1990: 514.

MATERIAL. Capt. Cook Hwy, c. 10km NW of Ellis Bch, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w).

REMARKS. The single specimen collected just north of Cairns is the only record from the Wet Tropics and extends the range of this species as listed by Kohout & Taylor (1990:514) by more than 500km. It is a ground-nesting species from open forests and woodlands, common in suitable localities from Mackay to southern Queensland.

Polyrhachis (Chariomyrma) hookeri
Lowne, 1865

Polyrhachis hookeri Lowne, 1865: 334.
(For full synonymy citations and other comments see Kohout & Taylor, 1990: 515 and Kohout, 1994: 136 and 1998: 511).

MATERIAL. Forty Mile Scrub, 18°05'S, 144°53'E, 5.v.1990 (BBL) (w); Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK et al. acc. 96.15) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c. 500m, 3.vi.1996 (RJK et al. acc. 96.11) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc. 87.91) (w).

REMARKS. This common species was described from Sydney and reaches its northern limit within the Wet Tropics. The specimens from Forty Mile Scrub differ somewhat from the other available material, however, for the purpose of this paper I regard them as an isolated population of *P. hookeri*. This species lives in open sclerophyll forests and woodlands where it nests either in the soil under rocks or logs, between grass roots or, occasionally, in pieces of decaying wood lying on the ground.

Polyrhachis (Chariomyrma) lata
Emery, 1895

Polyrhachis guerini subsp. *lata* Emery, 1895: 357.
Polyrhachis lata Emery; Kohout & Taylor, 1990: 515. Raised to species.

MATERIAL. Annan R. Xing, 3km SE, 15°33'S, 145°14'E, 10.vi.1996 (RJK acc. 96.35) (w); Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK et al. acc. 96.43) (w); Black Mtn Rd, 4km N of Kuranda, 16°47'S, 145°38'E, 21.vii.1980 (RJK acc. 80.102) (w); Stratford, Cairns, 16°53'S, 145°44'E, 10.viii.1989 (RJK acc. 89.4) (w); Atherton (E. Mjöberg) (*gab aegra* syntype w MHNG, NRMS); Bell Peak North, Malbon Thompson Ra., 17°05'S, 145°53'E, 800-900m, 19-22.xi.1990 (GBM & GT) (w); Mill Ck, above, 17°30'S, 145°27'E, 1000m, 5.ii.1999 (GBM & DJC) (w); Sth Mission Bch, 10km WbyN, 17°56'S, 146°00'E, 18-19.vii.1980 (RJK acc. 80.51) (w); Cardwell Ra., Murray R. Falls, 18°09'S, 145°49'E, 1-5.viii.1983 (RJK acc. 83.4) (w); Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK et al. acc. 96.15) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, <100m, 8-18.xi.1984 (GBM) (w); Cardwell Gap, 18°32'S, 146°11'E, 120m, 4-12.ii.1998 (GBM & DJC) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, 3.vi.1996 (RJK et al. acc. 96.43) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.x.1977 (RJK acc. 77.4) (w).

REMARKS. *Polyrhachis lata* mostly occurs in open forests and savannah woodlands, but has also been collected in rainforest and wet sclerophyll forest. It is known from Torres Strait south to Rundle Ra. near Gladstone.

Polyrhachis (Chariomyrma) lownei
Forel, 1895

Polyrhachis hookeri r. *lownei* Forel, 1895: 44.
Polyrhachis lownei Forel; Kohout & Taylor, 1990: 515. Raised to species.

MATERIAL. Windsor Tbld, SE, 16°18'S, 145°05'E, 850m, 9.ii.-17.v.1998 (GBM & DJC) (w); Hann Tbld Radar Stn, 16°55'S, 145°15'E, 950m, 26-27.xi.1998 (GBM, P. Bouchard & A. O'Toole) (w); Kuranda, 10mi W, 3.viii.1975 (BBL) (w); Kirrama, 15.iv.1976 (P.J.M. Greenslade) (w); Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK et al. acc. 96.15) (w); Mt Spec, 5mi W of summit, 14.viii.1975 (BBL) (w).

REMARKS. This is an uncommon species which has been infrequently collected at higher altitude wet sclerophyll or rainforest localities. It ranges patchily from Windsor Tbld south to Mackay.

Polyrhachis (Chariomyrma) obscura
Forel, 1895

Polyrhachis hookeri r. *obscura* Forel, 1895: 44.
Polyrhachis obscura Forel; Kohout & Taylor, 1990: 516. Raised to species.

MATERIAL. Mt Elliot NP, above St Margaret Ck, c. 350m, 27.vii.1980 (BBL) (w).

REMARKS. *Polyrhachis obscura* is evidently very rare and, apart from the types collected at

Mackay, the short series from St Margaret Ck are the only specimens known to me.

Polyrhachis (Chariomyrma) punctiventris
Mayr, 1876

Polyrhachis punctiventris Mayr, 1876: 73.

MATERIAL. Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c.500m, 3.vi.1996 (RJK et al. acc. 96.11) (w).

REMARKS. This is the only record of *P. punctiventris* from the Wet Tropics. It is relatively rare with a patchy distribution from Townsville south to near Maryborough in southeastern Queensland. It is a ground-nesting inhabitant of open forests.

Polyrhachis (Chariomyrma) schoopae
Forel, 1902
(Figs 2A, 4B)

Polyrhachis appendiculata r. *schoopae* Forel, 1902: 520.
Polyrhachis schoopae Forel; Kohout & Taylor, 1990: 519. Raised to species.

MATERIAL. Roaring Meg Valley, 16°04'S, 145°25'E, 680m, 20.xi.-9.xii.1993 (GBM) (w); Pilgrim Sands, NE of Cape Tribulation, 16°04'S, 145°28'E, 25.viii.1988 (R. Raven, Churchill & J. Gallon) (w); Mt Hemmant, 6km SW of Cape Tribulation, 16°06'S, 145°24'E, 25.iv.1983 (GBM & DJC) (w); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.117) (w); Hann Tbld Radar Stn, 16°55'S, 145°15'E, 800-900m, 8.ii.1996 (GBM) (w); Atherton Tbld, Yungaburra distr., Centre for Rainforest Studies, iv.1996 (A. Cuttler & J. King) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c. 500m, 3.vi.1996 (RJK et al. acc. 96.11) (w).

REMARKS. *Polyrhachis schoopae* is predominantly a rainforest or wet sclerophyll forest dwelling species distributed from Cape Tribulation south to Mackay.

Polyrhachis (Chariomyrma) senilis
Forel, 1902

Polyrhachis gab var. *senilis* Forel, 1902: 520.
Polyrhachis senilis Forel; Kohout, 1988a: 50. Raised to species.
(For full synonymy citations see Kohout, 1988a: 50).

MATERIAL. Helenvale, 15°42'S, 145°13'E, 10-20.vii.1976 (P. Filewood) (w); Davies Ck, 15km E of Mareeba, 17°00'S, 145°34'E, 15.vi.1980 (RJK acc. 80.27) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.48) (w); Paluma, ix.1997 (B. Hoffman) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.x.1977 (RJK accs 77.3, 7) (w).

REMARKS. This species is restricted to northern Australia and ranges from the Kimberly district in Western Australia, across the Northern Territory to Queensland where it has been collected as far south as Newry I. near Mackay. It inhabits mainly open forests and savannah woodlands and is common at suitable localities. It nests mostly in the soil or in rotting logs. On Cape York Pen. it frequently nests in termite mounds of *Amitermes* or *Nasutitermes* species.

Polyrhachis (Chariomyrma) sokolova
Forel, 1902
(Figs 2B, 3A)

Polyrhachis sokolova Forel, 1902: 522.
Polyrhachis sokolova var. *degener* Forel, 1910: 84. Synonymy by Kohout, 1988b: 436.
Polyrhachis sokolova Forel; Kohout, 1999: 221. Combination in *P. (Chariomyrma)*.

MATERIAL. Low I., 16°23'S, 145°33'E, 14.viii.1954 (M.J. Mackerras & E.N. Marks) (w); Port Douglas, 16°29'S, 145°28'E, 24.x.1982 (P. Davie) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, 8-18.xi.1984 (GBM) (w); Round Hill Landing, c. 15km SE of Cardwell, 18°22'S, 146°07'E, 1.xi.1984 (GBM) (w); Magnetic I., Cockle Bay, 12.xi.1996 (SKR #118) (w); Townsville Town Common, Three Mile Ck, 20.viii.1995 (SKR #01) (w).

REMARKS. As discussed earlier (Kohout, 1988b:436, 1999:221) *P. sokolova* holds a unique position within the Australian ant fauna by building their nests in the mud of the intertidal zone. This remarkable nesting habit has recently been studied in Darwin Harbour in the Northern Territory (Nielsen, 1997). Its known distribution extends from eastern Indonesia and New Guinea to New Caledonia. In Australia it occurs along the northern and eastern coastline from the Bonaparte Archipelago in Western Australia to the Northern Territory and from Torres Strait south to Gladstone.

Polyrhachis (Chariomyrma) vermiculosa
Mayr, 1876

Polyrhachis guerini var. *vermiculosa* Mayr, 1876: 74.
Polyrhachis vermiculosa Mayr; Kohout & Taylor, 1990: 520. Raised to species.

MATERIAL. Ross R., 25.ix.1997 (A.J. King #001) (w); Townsville, Field Training area/Tabletop, 19°27'S, 146°24'E, ii.1999 (A. Ash #99) (w); Bowling Green Bay NP, ix.1997 (B. Hoffman) (w).

REMARKS. *Polyrhachis vermiculosa* extends from northern Queensland south to Sydney in New South Wales. It is a common species in southeastern Queensland, but becomes less frequent north of the Tropic of Capricorn, with the northern limits of its distribution around Townsville.

Polyrhachis (Chariomyrma) sp.
('*Chario* 01')

MATERIAL. Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Windsor Tbld SE, 16°18'S, 145°05'E, 850m, 9.ii.-17.v.1998 (GBM & DJC) (w); Davies Ck, 15km E of Mareeba, 17°00'S, 145°34'E, 15.vi.1980 (RJK acc. 80.23) (w); Kirrama Ra., nr JCU Field Stn, c, 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK et al. acc. 96.15) (w).

REMARKS. This is a spectacular new species structurally similar to the Australian *P. schoopae* Forel. However, its colour scheme gives it a striking resemblance to the New Guinean *P. laciniata* Emery. Its distribution appears limited to the Wet Tropics.

Polyrhachis (Chariomyrma) sp.
('*Chario* 04')

Polyrhachis (Chariomyrma) hookeri r. lownei v. bellendenensis' Forel, 1915: 109.
Polyrhachis (Chariomyrma) hookeri obscura bellendensis' Forel; Taylor, 1986: 34. Unavailable name.

MATERIAL. Mt Hedley, 1-2km N of Home Rule, 15°45'S, 145°17'E, 200-300m, 11.vi.1996, rainforest. RJK acc. 96.44 (w, ♀); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, <10m, 12-15.vi.1996 (RJK acc. 96.47) (w); Mc Lean Ck, c. 19km SbyW of Cape Tribulation, 16°15'S. 145°26'E. 15.vi.1996 (RJK acc. 96.54) (w); Bellenden Ker (E. Mjöberg) ('*hookeri obscura bellendensis*' unique w NRMS); Mission Bch, 17°45'S, 146°00'E, 1996 (SKR #799) (w); Rocky Ck Xing, 6km W of Tully, 17°55'S, 145°53'E, 22.ix.1980 (BBL) (w); Broadwater Park, via Ingham, 18°22'S, 145°57'E, 400m. 3.i.1987 (S. Hamlet) (w).

REMARKS. This species was originally described from a unique specimen collected by Eric Mjöberg on Bellenden Ker. However, as it was described as a quadrinomen, the name is unavailable. It is a relatively common, rainforest-dwelling species, apparently endemic to the Wet Tropics.

Polyrhachis (Chariomyrma) sp.
('*Chario* 05')

MATERIAL. Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.48) (w); Forty Mile Scrub, 18°05'S, 144°53'E, 5.v.1990 (BBL) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c. 500m, 3.vi.1996 (RJK et al. acc. 96.11) (w, ♀); Alligator Ck, Bowling Green Bay NP, 19°26'S, 146°57'E, 2.vi.1996 (RJK et al. acc. 96.9) (w).

REMARKS. This new species is related to *P. lata* Emery. It differs by the distinctly less rugose pronotal dorsum and the metathoracic spiracles situated on prominent, posteriorly projecting tubercles, not unlike those in *P. tubifera* Forel or *P. stigmatifera* Kohout. Additional records outside the Wet Tropics are from Cape Hillsborough, Britton Ra., Rockhampton and as far south as Cooloola NP, north of Brisbane.

Polyrhachis (Chariomyrma) sp.
('*Chario* 06')

MATERIAL. Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996 (CJB) (w); Atherton Tbld, Yungaburra district, Donaghy's Corridor, iv.1996 (A. Cuttlet & J. King) (w).

REMARKS. This species appears intermediate between *P. obscura* Forel and *P.* '*Chario* 04' above. It appears to be endemic to the Wet Tropics.

Polyrhachis (Chariomyrma) sp.
('*Chario* 08')

MATERIAL. Black Mtn, NW base, 15°40'S, 145°13'E, 10.vi.1996 (CJB) (w); Bakers Blue Mtn, 17km W of Mt Molloy, 12.ix.1981 (GBM & DJC) (w); Hann Tbld, 16°48'S, 145°12'E, 500m, 11-14.xii.1995 (GBM, GT & DJC) (w); Wallaman Falls, 18°35'S, 145°48'E, 28.ix.1987 (RJK acc. 87.100) (w).

REMARKS. This is a new species with some similarity to *P.* '*Chario* 05'. However, it lacks the projecting metathoracic spiracles and is more stoutly built, with the mesosomal dorsum relatively wide. Its occurs from Cooktown south to Mackay.

Polyrhachis (Chariomyrma) sp.
('*Chario* 10')

MATERIAL. Annan R. Xing, 3km SE, 15°33'S, 145°14'E, 10.vi.1996 (RJK acc. 96.35) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. accs 2000.48, 63) (w, ♀); Sth Mission Bch, 2km NbyW, 17°55'S, 146°05'E, 18-19.vii.1980 (RJK acc. 80.82) (w); Cardwell Ra., Murray R. Falls, 18°09'S, 145°49'E, 1-5.viii.1983 (RJK acc. 83.4); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc, 87.95) (w).

REMARKS. This new species has more-or-less obtuse pronotal shoulders, resembling those of *P. obtusa* Emery from New Guinea and eastern Indonesia. However, it differs in several characters, including a more slender body, heavily sculptured pronotal dorsum and the propodeal and petiolar spines distinctly less divergent. It is known only from the Wet Tropics

Polyrhachis (Chariomyrma) sp.
('*Chario* 11')

MATERIAL. Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.48) (w).

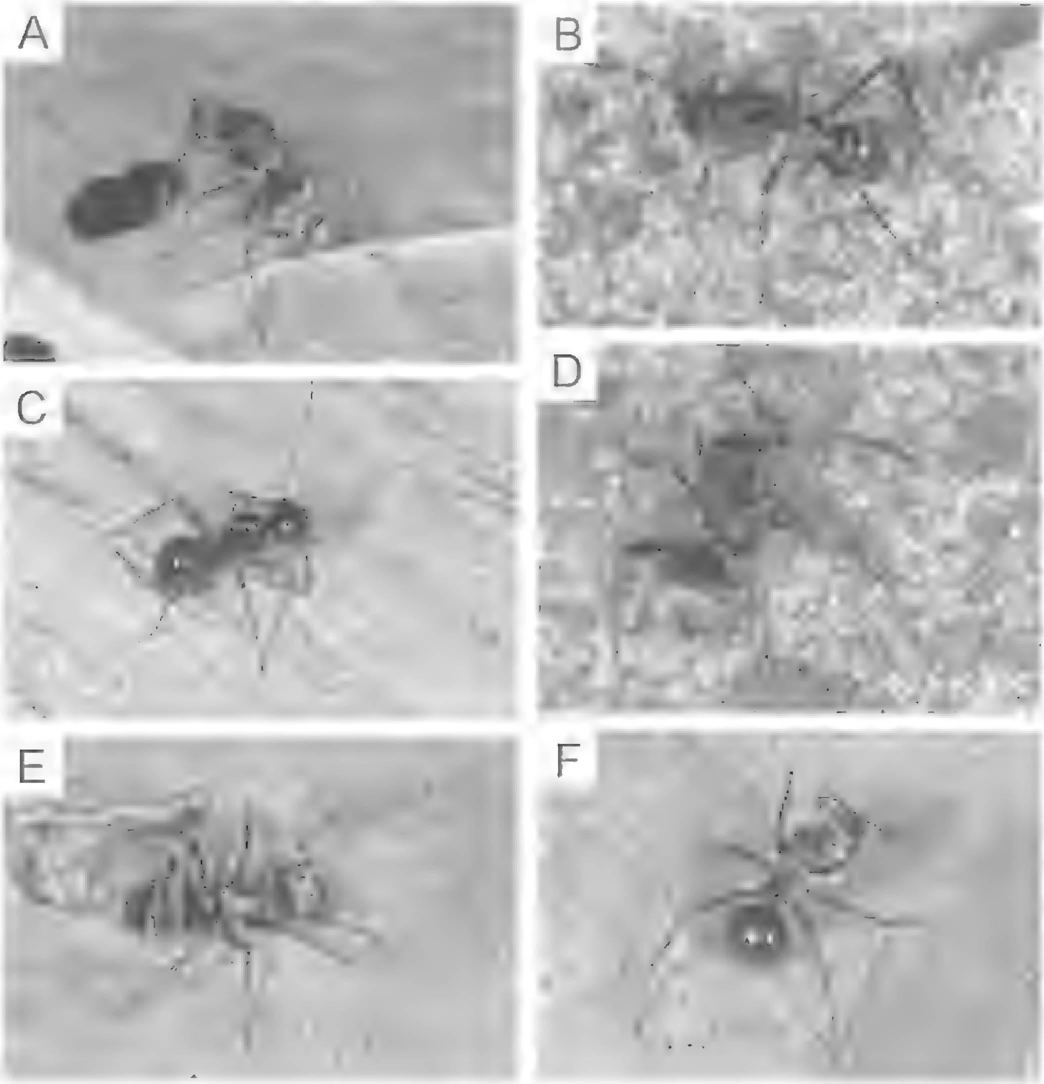

FIG. 2. Living workers of representative Wet Tropics *Polyrhachis* species. A, *P. (Chariomyrma) schoopae*; B, *P. (Chariomyrma) sokolova*; C, *P. (Cyrtomyrma) australis*; D, *P. (Hagiomyrma) thusnelda*; E, *P. (Hedomyrma) argentosa*; F, *P. (Hedomyrma) turneri*. (Photographs, Jeff Wright, QM)

REMARKS. A single specimen collected near Mareeba is the only record of this new species from the Wet Tropics. It is undoubtedly related to *P. schoopae* Forel, featuring similar, intricately carved, lateral margins of the mesosomal dorsum. However, besides other characters, it differs by its distinctly smaller size. It has also been collected at East Alligator R. in the Northern Territory and elsewhere in Queensland from Mackay south to Brisbane.

Polyrhachis (Chariomyrma) sp.
('*Chario* 13')

MATERIAL. Station Ck, upper, 16°37'S, 145°14'E, 370m, 3-11.ii.1999 (GBM & DJC) (w); Barratt Ck, c. 4km ESE of Daintree, 16°16'S, 145°21'E, 21.vii.1980 (RJK acc. 80.101) (w); Porter Ck, 23km SE of Cardwell, 18°26'S, 146°08'E, 26.ii.2000 (RJK et al. acc. 2000.68) (w); Wallaman Falls, 18°35'S, 145°48'E, 28.ix.1987 (RJK acc. 87.100) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.x.1977 (RJK acc. 77.7) (w).

REMARKS. This is yet another new species apparently related to *P. obtusa* Emery. It shares with that species (and with *P.* '*Chario* 10') the more-or-less obtusely spinose pronotal shoulders but it differs in having relatively wide mesonotal and propodeal dorsa and the propodeal spines distinctly broader at their bases. It is known only from the Wet Tropics.

Polyrhachis (Chariomyrma) sp.

('*Chario* 15')

MATERIAL. Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc.2000.48) (w).

REMARKS. A short series from Mareeba represents the only known specimens of this spectacular new species. It is immediately recognisable by its small size, widely diverging, short, propodeal spines and distinctly rounded propodeal dorsum.

Subgenus **Cyrtomyrma** Forel, 1915

Polyrhachis (Cyrtomyrma) australis

Mayr, 1870

(Figs 2C, 4C)

Polyrhachis australis Mayr, 1870: 945.

Polyrhachis (Cyrtomyrma) nox Donisthorpe, 1938: 249. Synonymy by Kohout & Taylor, 1990: 513.

Polyrhachis (Cyrtomyrma) doddi Donisthorpe, 1938: 263, Syn. nov.

(For full synonymy citations see Kohout & Taylor, 1990: 513 and Kohout, 1998: 527)

MATERIAL. Seaview Ra., Mt Fox Crater, 18°51'S, 145°48'E, 15.xii.1986 (GBM, GT & S. Hamlet) (w); Townsville, 17.v.1902 (F.P. Dodd) (*doddi* syntype w, ♀, ♂ BMNH); Townsville (F.P. Dodd) (*townsvillei* syntype w, ♀, ♂, BMNH); Townsville, 15.v.1902 (F.P. Dodd) (w); Townsville, JCU Campus, 19°15'S, 146°45'E, 13.iii.1996 (SKR #284) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c. 500m, 3.vi.1996 (RJK et al. acc. 96.11) (w).

REMARKS. When Donisthorpe described *P. nox* and *P. doddi*, he separated them by including the former into a group with 'shoulders toothed or angled' and the latter into a group with 'shoulders rounded'. However, I have directly compared syntypes of both species and found them taxonomically inseparable, with the outline of their shoulders virtually identical. Further examination of hundreds of specimens from across the whole distribution range supports my opinion that both forms are a single biological species. *Polyrhachis australis* ranges from just north of Townsville south to northern New South Wales and is common in suitable localities.

Polyrhachis (Cyrtomyrma) debilis

Emery, 1887

Polyrhachis laevior var. *debilis* Emery, 1887: 240.

Polyrhachis (Cyrtomyrma) debilis Emery: Donisthorpe, 1938: 265. Raised to species.

MATERIAL. Mt Hemmant, 6km SW of Cape Tribulation, 16°07'S, 145°25'E, 25.iv.1983 (GBM & DJC) (w); Cairns, Botanic Gardens, 16°54'S, 145°45'E, 1996 (SKR, #647) (w); Pine Ck CSIRO Tower, 17°00'S, 145°50'E, 80m, 22.x.1991 (GBM, DJC & HJ) (w); Babinda, 17°21'S, 145°56'E, 4.viii.1975 (BBL); Palmerston NP, 17°37'S, 145°40'E, 400m, 4.v.1997 (SKR #551) (w, ♀, ♂); Mission Bch. 17°45'S, 146°00'E, 10m, 1996 (SKR #648) (w, ♂).

REMARKS. A New Guinea-based species similar to *P. yorkana* Forel and their close relationship is considered below under that species. In Australia it is apparently limited to the Wet Tropics.

Polyrhachis (Cyrtomyrma) mackayi

Donisthorpe, 1938

Polyrhachis (Cyrtomyrma) mackayi Donisthorpe, 1938: 258

MATERIAL. Mission Bch, 17°52'S, 146°05'E, 10m, 19.x.1996 (SKR #646) (w).

REMARKS. This species is very similar to *P. rastellata* (Latreille) from south-east Asia and both were considered synonymous by Than (1978). I have examined the syntypes of *P. mackayi* and a number of specimens of *P. rastellata* from India and Sri Lanka (some identified by Than) and compared them with abundant material of *P. mackayi* from Queensland and northern New South Wales. I found them undoubtedly related, but differing in a number of characters, including the shape of pronotal dorsum and configuration of the petiolar spines. Therefore I believe that the two names represent closely related, but distinct species. *P. mackayi* is relatively common, with its main distribution range extending from about Mackay south to Taree in northern New South Wales. It also occurs in northern Queensland, but is relatively rare towards the northern limits of its distribution. *Polyrhachis rastellata* was earlier listed for Australia (Kohout & Taylor, 1990), but now appears to be an extralimital element.

Polyrhachis (Cyrtomyrma) pilosa

Donisthorpe, 1938

'*Polyrhachis rastellata* r. *laevior* var. *pilosa*' Forel, 1902: 527.

Polyrhachis (Cyrtomyrma) rastellata var. *pilosa* Donisthorpe, 1938: 256. First available use of '*P. rastellata laevior pilosa*' Forel

Polyrhachis pilosa Donisthorpe: Kohout & Taylor, 1990: 518. Raised to species.

MATERIAL. Crystal Ck NP, 18°59'S, 146°09'E, c. 330m, 11.i.1977 (BBL) (w); Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM, GT & S. Hamlet) (w).

REMARKS. Two specimens listed are the only records of this species from Wet Tropics. It is not uncommon within its main distribution which is essentially identical to that of *P. australis* and *P. mackayi*.

Polyrhachis (Cyrtomyrma) yorkana
Forel, 1915
(Fig. 3B)

Polyrhachis (Cyrtomyrma) rastellata var. *yorkana* Forel, 1915: 110.
Polyrhachis yorkana Forel; Kohout & Taylor, 1990: 521. Raised to species.

MATERIAL. Cape Tribulation, 16°04'S, 145°28'E, 16.vi.1997 (SKR #583) (w); Trinity Bch, 17km NNW of Cairns, 16°47'S, 145°41'E, 13.v.1974 (RJK acc. 74.28) (w, ♂); 'Cape York' (E. Mjöberg) (*rastellata yorkana* syntype w NRMS, MHNG, ANIC, QMBA); Russel R., Bellenden Ker landing, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w, ♀).

REMARKS. *Polyrhachis yorkana* is similar to *P. debilis* and the two were considered synonyms by Than (1978). Both share the peculiar variability in development of the propodeal spines. These may be sharp, upturned denticles, or present only as tubercules, or completely absent, even within a single colony. However, the species differs in a number of characters and, for the purpose of this paper, I consider *P. yorkana* distinct from *P. debilis*. The distribution of *P. yorkana* appears to be centred on the Wet Tropics, however, it has also been recorded from Wenlock R. on Cape York Pen. (P. Filewood).

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 03')

MATERIAL. Home Rule, 15°45'S, 145°17'E, 9-11.vi.1996 (RJK et al. 96.39, 40) (w, ♀, ♂); Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Pilgrim Sands, 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 12-15.vi.1996 (RJK acc. 96.47) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK accs 2000.21, 23, 25, 28, 29, 31, 34, 39) (w); Oliver Ck, 16°08'S, 145°26'E, 14.vi.1996 (RJK acc. 96.53) (w); McLean Ck, c.19km SbyW of Cape Tribulation, 16°15'S, 145°26'E, 15.vi.1996 (RJK acc. 96.54) (w); O'Donoghues Falls, 16°26'S, 145°20'E, 15-16.v.1995, 150m (GBM, Ford & Slaney) (w); Julatten, 16°37'S, 145°20'E, 2.v.1990 (BBL) (w); Black Mtn Rd, 4km N of Kuranda, 16°47'S, 145°38'E, 21.vii.1980 (RJK acc.80.104) (w); Hann Tbld, 16°49'S, 145°11'E, 1000m, 11-13.xii.1995 (DJC) (w); Kennedy Hwy, 4km ESE of Kuranda, 16°50'S, 145°40'E, 12.v.1974 (RJK accs 74.25, 26) (w, ♀, ♂); Yarrabah, c. 11km E of Cairns, 16°56'S, 145°52'E, 22-24.vii.1980 (RJK acc. 80.111) (w); Bellenden Ker, Cableway Base Stn, 8-23.iv.1987 (E. Dahms & G. Sarnes) (w); Russell R., Bellenden Ker Landing, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w); Atherton Tbld, xii.1983 (J. Sedlacek) (w); 'The Boulders', c. 6km W of Babinda, 17°20'S, 145°52'E, 1990 (W. Travers) (w, ♀, ♂); Josephine Falls, 17°26'S, 145°51'E, 12.ii.1996 (GBM) (w); Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996 (RJK et al. accs 96.22, 30) (w, ♀, ♂) Garradunga, 17°28'S, 146°01'E, 7.xi.1996 (IPH) (w); Palmerston NP, 17°37'S, 145°48'E, 350-400m, 2.i.1990 (GBM) (w); Sth Mission Bch, 6km W, 17°56'S, 146°02'E, c. 20m, 5.vi.1996 (RJK et al. acc. 96.17) (w, ♀); Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, c. 110m, 31.x.1999 (SKR #808) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, <100m, 8-18.xi.1984 (GBM) (w); Townsville, JCU Campus, 19°15'S, 146°45'E, 21.viii.1995 (SKR #4) (w).

REMARKS. This is the most common *Cyrtomyrma* species north of Townsville where it virtually replaces *P. australis*. It extends from Cape York Pen. south to Mackay.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 04')

MATERIAL. Caravonica, 10km NW of Cairns, 16°51'S, 145°41'E, 19.v.1996 (SKR #316, 317) (w); Babinda, Double Barrel Ck, 25.i.1994 (C.J. Hill) (w, ♀).

REMARKS. This species is intermediate between *P.* '*Cyrto* 05', below, and the Indonesian *P. rastellata goramensis* Emery, originally described from Goram I.. However, it differs from the former by its larger size and from both species in having the pronotal dorsum with only an indication of humeral angles. These, in *P.* '*Cyrto* 05', are produced into distinct teeth while in *P. rastellata goramensis* the shoulders are evenly and widely rounded. *P.* '*Cyrto* 04' also differs in having the lateral petiolar spines only slightly longer than the dorsal pair, while these are distinctly elongated in *P. rastellata goramensis*. The distribution of this species is apparently limited to the Wet Tropics.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 05')

MATERIAL. Home Rule, 32km S of Cooktown, 15°45'S, 145°18'E, x-xi.1974 (T.P. Tebble) (w, ♀); Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Cape Tribulation NP, 16°04'S, 145°27'E, 6.xii.1985 (RJK acc. 85.6) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK acc. 2000.40) (w, ♀, ♂); Noah Ck, 16°08'S, 145°25'E, 13-19.x.1980 (GBM) (w); McLean Ck, c. 19km SbyW of Cape Tribulation, 16°15'S, 145°26'E, 15.vi.1996 (RJK acc. 96.54) (w); Daintree R. Xing, 16°15'S, 145°23'E, 16.vi.1997 (SKR #555, 557, 559, 561, 563, 565, 569, 571, 575,) (w, ♀); Oak Bch, 16°36'S, 145°31'E, 10m, 18.v.1998 (GBM) (w); Caravonica, 10km NW of Cairns, 16°51'S, 145°41'E, 2.iii.1996 (SKR #241, 316) (w, ♀, ♂); Lake Placid, 16°52'S., 145°40'E, 18.x.1995 (SKR #57) (w); Cairns, Botanic Gardens, 16°54'S, 145°45'E, 18.i.1997 (SKR #465, 490, 493) (w, ♀); Russell R., Bellenden Ker landing, 17°16'S, 145°56'E, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w); Bellenden Ker, Cableway Base Stn. 17°16'S, 145°53'E, 8-23.iv.1987 (E.C. Dahms & G. Sarnes) (w); Babinda, Double Barrel Ck, 25.i.1994 (C.J. Hill) (w, ♀); Mission Bch. 17°52'S, 146°05'E, 10m. 5.vi.1996 (SKR #405) (w, ♀); Sth Mission Bch, 6km W, 17°56'S, 146°02'E, 5.vi.1996 (RJK) (w).

REMARKS. This species is characterised by its relatively highly arched mesosomal dorsum with a distinct depression at the propodeal suture, pronotal shoulders with well-defined teeth and a lack of propodeal spines. It is common from Cape York Pen. south to near Mission Beach.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 06')

MATERIAL. Parrot Ck, upper, 15°48'S, 145°16'E, 300m. 22.xi.1998 (GBM & P. Bouchard) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 1.i.1991 (R. Kitching) (w); Cape Tribulation, 16°04'S, 145°28'E, 9.v.1997 (SKR #550) (w); Noah Ck, S of Cape Tribulation, 16°08'S, 145°25'E, 13-19.x.1980 (GBM) (w); ditto, 25-28.vii.1993 (H. Mitchell) (w); Smithfield. Cairns, 16°50'S, 145°41'E, 5.v.1997 (SKR #553) (w); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°53'E, 17-24.x.1981 (GBM & Earthwatch Exp.) (w); Mission Bch, 17°45'S, 146°00'E, 10m. 29.ii.1996 (SKR #256) (w, ♀, ♂); Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, c. 110m, 4.vi.1996 (RJK et al. accs 96.13, 14) (w); Hinchinbrook I., Gayundah Ck, <100m, 8-18.xi.1984 (GBM) (w); Paluma Ra., Little Crystal Ck, 29.ii.1996 (SKR #147) (w).

REMARKS. This species appears to be closely related to *P. semiinermis* Donisthorpe from the Philippines and it shares with that species the parallel-sided petiole with rudimentary spines. However they differ in other aspects and, because of the considerable distance separating their distributions, I prefer to consider them distinct rather than as distant populations of a single species. The known distribution of the Australian species extends from Cape York Pen. south to Hinchinbrook I., while *P. semiinermis* is known only from the Philippines and northern Borneo.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 07')

MATERIAL. Davies Ck, 20km E of Mareeba, 17°02'S, 145°37'E, 15.vi.1980 (RJK acc. 80.19) (w).

REMARKS. The unusual colour scheme of this species sets it apart from all other Australian members of the subgenus *Cyrtomyrma*. The reddish-brown body and honey-yellow gaster and appendages are peculiar in a subgenus in which most species are uniformly black. The small series from Davies Ck, collected by sweeping low vegetation along the rainforest edge, are the only known specimens.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 08')

MATERIAL. Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 8.ix.1999 (N. Blüthgen #1002) (w); Black Mtn Rd, nr Kuranda, 16°47'S, 145°38'E, 21.vii.1980 (RJK acc. 80.103) (w); Davies Ck, 17km E of Mareeba, 17°01'S, 145°35'E, 15.vi.1980 (RJK acc. 80.20) (w); Palmerston NP, 17°37'S, 145°48'E, 350-400m, 2.i.1990 (GBM) (w); Mission Bch, 17°45'S, 146°00'E, 10m, 29.ii.1996 (SKR #253) (w, ♀); Upper Boulder Ck, 8km N of Tully, 17°49'S, 145°54'E, 100-500m, 4.xii.1989 (GBM, GT & HJ) (w).

REMARKS. This species closely resembles *P. yorkana*, however its considerably smaller size and rather well developed, although short, propodeal spines, set it well apart. It appears restricted to the Wet Tropics.

Polyrhachis (Cyrtomyrma) sp.
('*Cyrto* 09')

MATERIAL. Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, c. 110m, 4.vi.1996 (RJK et al. acc. 96.13) (w).

REMARKS. With a strongly transverse pronotal dorsum, featuring clearly bilobed shoulders, and well developed propodeal spines, this species stands relatively close to *P. levior* Roger, 1863 (= *laevissima* Fr. Smith, 1859) from Aru Islands. I consider it to be intermediate between that species and *P. australis* Mayr. The only known specimens were collected on a single occasion by sweeping and beating low rainforest foliage and other vegetation.

Subgenus **Hagiomyrma** Wheeler, 1911

Polyrhachis (Hagiomyrma) ammon
(Fabricius, 1775)

Formica ammon Fabricius, 1775: 394.
Polyrhachis ammon (Fabricius): Fr. Smith, 1858: 73.

MATERIAL. Hann Tbld. (Nth End), 16°48'S, 145°10'E, 950-1000m, 11-14.xii.1995 (GBM, GT& DJC) (w); Davies Ck NP, 17°31'S, 145°35'E, 7.vi.1996 (RJK & CJB); Mill Ck, above, 18°32'S, 146°11'E, 1000m, 5.ii.1999 (GBM & DJC) (w); Kirrama Ra., 18°10'S, 145°44'E, c. 600m, 26.viii.1987 (RJK acc. 87.97) (w); Mt Stuart summit, Townsville, c. 580m, 20.ii.1980 (BBL) (w).

REMARKS. *Polyrhachis ammon* is a widespread, common species along the eastern Australian seaboard. It ranges from north Queensland south to Victoria, however, it becomes rather uncommon towards the northern limits of its distribution. All localities within the Wet Tropics are at higher elevations.

Polyrhachis (Hagiomyrma) crawleyi Forel, 1916

Polyrhachis (Hagiomyrma) ammonoeides var. *crawleyi* Forel, 1916: 447.
Polyrhachis crawleyi Forel; Kohout, 1988b: 433. Raised to species.

MATERIAL. Cardwell, 14.ii.1992 (C.J. Hill) (w); Townsville, 3.xii.1901 (F.P. Dodd) (w, ♀).

REMARKS. This is a relatively rare, ground-nesting, species known from only a few isolated collections. It ranges from the Kimberley region in Western Australia to the Northern Territory, east along the Gulf of Carpentaria to Cape York Pen. and south to about Rockhampton.

Polyrhachis (Hagiomyrma) lachesis Forel, 1897

Polyrhachis lachesis Forel (in Emery), 1897: 582.

MATERIAL. Black Mtn, NW base, 15°40'S, 145°13'E, 10.vi.1996 (CJB) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. accs 2000.41, 45, 53, 58, 59) (w, ♀, ♂); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc.87.94) (w); Giru, c. 30km N, 28.iii.1980 (BBL) (w).

REMARKS. This species is uncommon with patchy distribution records ranging from Lakefield NP on Cape York Pen. south to Rundle Ra. near Gladstone. Like most *Hagiomyrma* species, it is a ground-nesting inhabitant of open forests and woodlands.

Polyrhachis (Hagiomyrma) lydiae Forel, 1902

Polyrhachis schenki r. *lydiae* Forel, 1902: 523.
Polyrhachis lydiae Forel; Kohout, 1988b: 434. Raised to species.

MATERIAL. Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK acc. 96.15) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc. 87.93) (w).

REMARKS. This species ranges along the eastern Australian coastline from north Queensland south to central New South Wales. It is common in open eucalypt forests and woodlands.

Polyrhachis (Hagiomyrma) penelope Forel, 1895 (Fig. 4D)

Polyrhachis penelope Forel, 1895: 46.

MATERIAL. 10km NW of Ellis Bch, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); Yarrabah, c. 11km E of Cairns, 16°56'S, 145°52'E, 22-24.vii.1980 (RJK acc. 80.121) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. accs 2000.50, 52, 57, 60) (w, ♀); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc. 87.88) (w); 1km E of Mingela, 19°53'S, 146°38'E, 5.i.1977 (BBL) (w).

REMARKS. *Polyrhachis penelope* was originally described from Mackay and its known range extends from Ellis Beach, just north of Cairns, south to about Rockhampton. It is rather uncommon and some previous records are undoubtedly referable to one of three closely related, as yet undescribed, species (*P.* '*Hagio* 04', *P.* '*Hagio* 11' and *P.* '*Hagio* 14' below).

Polyrhachis (Hagiomyrma) schenckii Forel, 1886

Polyrhachis schenckii Forel, 1886: 198.

MATERIAL. 3km SE of Annan R. Xing, 15°33'S, 145°14'E, 10.vi.1996 (RJK acc. 96.35) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. accs 2000.54, 62) (w, ♀, ♂); Townsville, 21.x.1902 (F.P. Dodd) (w); 10km SW of Giru, 7.iii.1980 (BBL) (w).

REMARKS. *Polyrhachis schenckii* is an uncommon species originally described from Darnley I. in Torres Strait. It is now known from New Guinea, the Northern Territory, and Queensland from Cape York Pen. south to Clermont.

Polyrhachis (Hagiomyrma) thusnelda Forel, 1902 (Figs 2D, 3C)

Polyrhachis thusnelda Forel, 1902: 509.

MATERIAL. Cape Tribulation, Canopy Crane site, 16°06'S, 145°27'E, 8.ix.1999 (N. Blüthgen #1008) (w); Hann Tbld (Nth Base), 16°48'S, 145°12'E, 500m, 11-14.xii.1995 (GBM, GT & DJC) (w); Davies Ck, 15km E of Mareeba, 17°00'S, 145°34'E, 15.vi.1980 (RJK accs 80.26, 29) (w); Hidden Valley, Paluma Ra., xi.1997 (B. Hoffman) (w); Mt Stuart, Townsville, 19°21'S, 146°47'E, 12.iii.1993 (GBM) (w); Mt Elliot NP, St Margaret Ck nr Giru, 18.iv.1980 (BBL) (w);

REMARKS. *Polyrhachis thusnelda* is an uncommon species ranging from Cape Tribulation south to Mackay. It mostly inhabits open sclerophyll forests, but has also been collected from the canopy of lowland tropical rainforest.

Polyrhachis (Hagiomyrma) trapezoidea Mayr, 1876

Polyrhachis trapezoidea Mayr, 1876: 72.

MATERIAL. 3km SE of Annan R. Xing, 15°33'S, 145°14'E, 10.vi.1996 (RJK acc. 96.35) (w); Black Mtn, NW base, 15°40'S, 145°13'E, 10.vi.1996 (CJB) (w); Bakers Blue Mtn, 17km W of Mount Molloy, 12.ix.1981 (GBM & DJC) (w); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. acc. 2000.51) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.ix.1977 (RJK acc. 77.5) (w).

REMARKS. *Polyrhachis trapezoidea* ranges from Torres Strait south to Rockhampton and also occurs in the Northern Territory. It is common in savannah woodlands and open forests.

Polyrhachis (Hagiomyrma) tubifera Forel, 1902

Polyrhachis tubifera Forel, 1902: 517.

MATERIAL. Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK acc. 96.43) (w); Barratt Ck, 4km ESE of Daintree, 16°16'S, 145°21'E, 21.vii.1980 (RJK acc. 80.100) (w); 10km NW of Ellis Bch, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); 1km NW of Buchan Point, 16°44'S, 145°39'E, 3-11.ii.1999 (GBM & DJC) (w); Hann Tbld, (Nth End), 16°48'S, 145°10'E, 11-14.xii.1995, 950-1000m (GBM, GT& DJC) (w, ♀, ♂); Chewko Rd, 2-3km SW of Mareeba, 17°01'S, 145°24'E, 23-25.ii.2000 (RJK et al. accs 2000.46) (w); Davies Ck NP, 17°31'S, 145°35'E, 7.vi.1996 (RJK & CJB); Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK acc. 96.15) (w); Porter Ck, 23km SE of Cardwell, 18°26'S, 146°08'E, 26.ii.2000 (RJK et al. acc. 2000.66) (w); Hinchinbrook I., v.1998 (A.D. Cutter) (w); Wallaman Falls, 18°35'S, 145°48'E, 28.ix.1987 (RJK acc. 87.99) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc. 87.89) (w).

REMARKS. *Polyrhachis tubifera* occurs commonly from Iron Ra. on Cape York Pen. south to Cooloola NP north of Brisbane.

Polyrhachis (Hagiomyrma) sp.

('*Hagio* 03')

MATERIAL. Townsville, 12.xi.1901 (W.W. Froggatt) (w); Townsville, 25.ix.1919 (G.F. Hill #H1119) (w); Major Ck, 22km SW of Giru, 25.v.1980 (BBL) (w, ♀).

REMARKS. This species was evidently regarded by Forel as *P. ammonoeides* Roger. Specimens collected by E. Mjöberg at Laura on Cape York Pen. are lodged in MHNG, MNHU and NRMS and bear Forel's identification labels '*Polyrhachis ammonoeides* Roger'. It ranges from Laura on Cape York Pen. south to Mackay. (A short series of alate ♀ were recently collected at light at Virginia, near Darwin, Northern Territory (B. Hoffman).

Polyrhachis (Hagiomyrma) sp.

('*Hagio* 04')

MATERIAL. Mt Finnigan, summit, 1100m, 19-21.iv.1982 (GBM) (w); ditto, 28-30.xi.1985 (GBM, DJC & L. Roberts) (w, ♀); Thornton Peak, 16°10'S, 145°23'E, 1374m, viii.1984 (GBM) (w); Mt Bartle Frere, Sth Peak, 17°24'S, 145°49'E, 8.xi.1981 (GBM & Earthwatch Exp.) (w); Koombooloomba T'ship, 2.5km WSW, 17°50'S, 145°34'E, 740m, 4.ii.-15.iv.1999 (GBM & S.R. Monteith) (w); Cardwell Ra., Macalister Mts, 18°18'S, 145°55'E, 800-900m, 13-16.i.1987 (S. Hamlet) (w); Cardwell Ra., Upper Broadwater Ck, 17-21.xii.1986 (GBM, GT & S. Hamlet) (w).

REMARKS. This new species is restricted to high elevations including the 1600m summit of Mt Bartle Frere. It is relatively close to *P. penelope*, originally described from Mackay, but differs in a number of characters. I am confident that it represents a distinct species. It is endemic to the Wet Tropics.

Polyrhachis (Hagiomyrma) sp.

('*Hagio* 10')

MATERIAL. Black Mtn, NW base, 15°40'S, 145°13'E, 10.vi.1996 (CJB) (w); Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK acc. 96.43) (w); Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996 (CJB) (w); Ellis Bch, 10km NW, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); Sth Mission Bch, 6km W, 17°56'S, 146°02'E, 18-19.vii.1980 (RJK acc. 80.62) (w); Porter Ck, 23km SE of Cardwell, 18°26'S, 146°08'E, 26.ii.2000 (RJK et al. acc. 2000.66) (w); Hinchinbrook I., v.1998 (A.D. Cutter) (w).

REMARKS. This species ranges from Iron Ra. on Cape York Pen. south to about Ingham. It is a common species in low altitude open forests.

Polyrhachis (Hagiomyrma) sp.

('*Hagio* 11')

MATERIAL. Davies Ck, 15km E of Mareeba, 17°00'S, 145°34'E, 15.vi.1980 (RJK acc. 80.25) (w); 1km E of Mingela, 19°53'S, 146°38'E, 5.i.1977 (BBL) (w).

REMARKS. This widespread species ranges from the Kimberley region of North Western Australia and Northern Territory to northern Queensland where it occurs from Cape York Pen. south to Rundle Ra. near Gladstone. It is another close relative of *P. penelope* Forel (see *P.* '*Hagio* 04' above). It is relatively common in open woodlands.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 14')

MATERIAL. Davies Ck, 3km of Kennedy Hwy, nr Mareeba, 3.viii.1975 (BBL) (w).

REMARKS. A small series of workers collected by B.B. Lowery at Davies Ck are the only known specimens of this species. It is closely related to *P. penelope* Forel and particularly to *P. denticulata* Karavaiev from New Guinea, which was only recently reported from Mabuiag I. in Torres Strait (Kohout & Taylor, 1990:541). The collection locality is open forest.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 16')

MATERIAL. Paluma, 18km W, 3.ii.1980 (BBL) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, c. 500m, 3.vi.1996 (RJK et al. accs 96.10, 11) (w).

REMARKS. The distribution of this new species extends from Paluma Ra. south to Rockhampton and westwards to Carnarvon Gorge.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 17')

MATERIAL. Herberton, 10km W, c. 17°23'S, 145°17'E, 15.ix.1981 (BBL) (w); Porter Ck, 23km SE of Cardwell, 18°26'S, 146°08'E, 26.ii.2000 (RJK et al. acc. 2000.67) (w).

REMARKS. This species is close to *P. lydiae* from Mackay, however its structural characters and colour clearly show it to be distinct. It inhabits a wide variety of habitats, from the savannah woodlands on the western slopes of Atherton Tbld, to coastal *Melaleuca* swamps. It is apparently endemic to the Wet Tropics.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 18')

MATERIAL. Windsor Tbld, 28km NNW of Mt. Carbine, c. 16°15'S, 145°02'E, 15-18.iv.1982 (GBM, D. Yeates & DJC) (w).

REMARKS. A rare species which is known from three, widely separated populations, the northern on Windsor Tbld and the two southern ones on Blackdown Tbld and Mt Moffat NP. All are high altitude, open forest localities.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 20')

MATERIAL. Hann Tbld (Nth End), 16°48'S, 145°10'E, 950-1000m, 11-14.xii.1995 (GBM, GT & DJC) (w, ♀); Paluma, 12km W, 3.ii.1980 (BBL) (w).

REMARKS. This species is related to *P. ammon* (Fabricius). However, the relatively small, quadrate, pronotal dorsum and its dense pubescence and pilosity clearly distinguish it. It is known only from two separate populations within the Wet Tropics.

Polyrhachis (Hagiomyrma) sp.
(*'Hagio* 21')

MATERIAL. Paluma, 18km W, c. 800m, 23.iii.1981 (BBL) (w); Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM, GT & S. Hamlet) (w); Mt Elliot, N ridge, 19°29'S, 146°58'E, 790m, 5.vii.1977 (RWT acc. 77.240) (w).

REMARKS. In general appearance this species is very similar to *P. trapezoidea* Mayr, however the petiole lacks the characteristic sloping dorsum of the latter species. Specimens from Paluma differ slightly from those from Mt Elliot, but I am confident they only represent a different population of a single species. It is evidently endemic to the Wet Tropics.

Subgenus **Hedomyrma** Forel, 1915

Polyrhachis (Hedomyrma) argentosa
Forel, 1902
(Fig. 2E)

Polyrhachis daemeli r. *argentosa* Forel, 1902: 515.
Polyrhachis argentosa Forel; Kohout, 1988b: 431. Raised to species.

MATERIAL. Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Mt Lewis, Upper Leichhardt Ck, 16°35'S, 145°16'E, 840m, 18.xi.1997 (GBM) (w); Kuranda, 16°50'S, 145°37'E, 5.iii.1992 (H. Reichel) (w); Whitfield Ra., 16°57'S, 145°42'E, 500m, 26.viii.1991 (GBM & HJ) (w); Davies Ck, 17km E of Mareeba, 17°01'S, 145°35'E, 15.vi.1980 (RJK acc. 80.21) (w); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°53'E, 17-24.x.1981 (GBM & Earthwatch Exp.) (w), Etty Bay, 7km ESE of Innisfail, 17°35'S, 146°05'E, 23.vii.1980 (RJK acc. 80.157) (w); Palmerston NP, Crawfords Lookout, 17°38'S, 145°49'E, 23.vii.1980 (RJK acc. 80.154) (w); Forty Mile Scrub NP, 18°05'S, 144°53'E, 25.viii.1996 (JPH) (w); Kirrama Ra., 18°11'S, 145°52'E, 19.ii.2000 (RJK acc. 2000.4) (w); Seaview Ra., Mt Fox Crater, 18°51'S, 145°48'E, 15.xii.1986 (GBM, GT & S. Hamlet) (w); Paluma Ra., Little Crystal Ck, 29.ii.1996 (SKR #144) (w); Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM, GT & S. Hamlet) (w).

REMARKS. This species extends from south of Cooktown to Rundle Ra. near Gladstone. It inhabits rainforests and wet sclerophyll forests, but has also been collected from higher altitude open forests. Like most *Hedomyrma* it is a lignicolous species nesting mostly in hollow twigs and small branches.

Polyrhachis (Hedomyrma) barretti
Clark, 1928

Polyrhachis (Hedomyrma) barretti Clark, 1928: 170.

MATERIAL. Mt Hedley, 1-2km N of Home Rule, 15°45'S, 145°17'E, 200-300m, 11.vi.1996 (RJK et al. acc. 96.44) (w); Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Oliver Ck, c. 8km SW of Cape Tribulation, 16°08'S, 145°26'E, 14.vi.1996 (RJK acc. 96.53) (w); Barratt Ck, 4km ESE of Daintree, 16°16'S, 145°21'E, 21.vii.1980 (RJK acc. 80.99) (w); Port Douglas, viii.1928 (C.L. Barrett) (*barretti* syntype w MVMA); Ellis Bch. 10km NW, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); Black Mtn Rd, 4km N of Kuranda, 16°47'S, 145°38'E, 21.vii.1980 (RJK acc. 80.108) (♀); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.116) (w);'The Boulders', 6km W of Babinda, 17°21'S, 145°52'E, 20.vii.1980 (RJK acc. 80.98) (w); Mission Bch, 2km W, 17°52'S, 146°05'E, 18-19.vii.1980 (RJK accs 80.86, 92) (w); Sth Mission Bch, 6-10km W, 17°56'S, 146°02'E, 18-19.vii.1980 (RJK acc. 80.61) (w); Porter Ck, 23km SE of Cardwell, 18°26'S, 146°08'E, 26.ii.2000 (RJK et al. acc. 2000.4) (w, ♀).

REMARKS. *Polyrhachis barretti* is known from Cape York Pen, south to Mission Beach. It is common in suitable localities along edges of lowland rainforest.

Polyrhachis (Hedomyrma) cleopatra
Forel, 1902

Polyrhachis cleopatra Forel, 1902: 513.

MATERIAL. Kirrama Ra., 18°11'S, 145°44'E, 29.ii.1996 (SKR #155) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, 24.ix.1995 (SKR #17) (w); Mt Elliot NP, St Margaret Ck, 19°29'S, 147°01'E, 23.ix.1995 (SKR #9) (w).

REMARKS. *Polyrhachis cleopatra* is relatively uncommon and many past records from the Wet Tropics are, in fact, referable to a new species (*P.* '*Hedo* 13' below). Both are predominantly rainforest species, but have also been recorded from wet sclerophyll and open forest localities. *P. cleopatra* appears to be centred on the greater Mackay area, including the Whitsundays, with only a few confirmed records from the southern limits of the Wet Tropics area.

Polyrhachis (Hedomyrma) clio Forel, 1902

Polyrhachis clio Forel, 1902: 515.

MATERIAL. Hann Tbld (Nth End), 16°49'S, 145°11'E, 1000m, 13.xii.1995 (GBM, GT & DJC) (w); Atherton Tbld, Yungaburra region, Tolga Scrub, iv.1996 (A. Cutter & J. King) (w); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°54'E, 17-24. ix. 1981 (GBM & Earthwatch Exp.) (w); Etty Bay, 7km ESE of Innisfail, 17°33'S, 146°05'E, 23. vii. 1980 (RJK acc. 80.157) (w).

REMARKS. This is a rainforest species favouring areas along the edges of lowland rainforest. It is known from Iron Ra. on Cape York Pen. south to Brunswick Heads in northern New South Wales, and from the Northern Territory.

Polyrhachis (Hedomyrma) clotho Forel, 1902

Polyrhachis clotho Forel, 1902: 525.
Polyrhachis clotho Forel; Kohout & Taylor, 1990: 512. Combination in *P. (Hedomyrma)*.

MATERIAL. Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 2.ix.1977 (RJK acc. 77.6) (w).

REMARKS. *Polyrhachis clotho* ranges from Lakefield NP on Cape York Pen. south to Mackay. It inhabits coastal open forests and woodlands.

Polyrhachis (Hedomyrma) cupreata
Emery, 1895
(Fig. 4E)

Polyrhachis hermione var. *cupreata* Emery, 1895: 357.
Polyrhachis (Hedomyrma) daemeli var. *exlex* Forel, 1915:110. Synonymy by Kohout, 1988b: 433.
Polyrhachis cupreata Emery; Kohout, 1988b: 433. Raised to species.

MATERIAL. Mt Hedley, 1-2km N of Home Rule, 15°45'S, 145°17'E, 200-300m, 11.vi.1996 (RJK et al. acc. 96.44) (w); Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK et al. acc. 96.43) (w, ♀); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°26'E, 12-15.vi.1996 (RJK et al. acc. 96.47) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK acc. 2000.19) (w); Ellis Bch, 10km NW, 16°40'S, 145°34'E, 8.vi.1996 (RJK et al. acc. 96.33) (w); Trinity Bch, 17km NNW of Cairns, 16°47'S, 145°41'E, 13.v.1974 (RJK acc. 74.30) (w, ♀); Cairns (M. Podenzana) (*cupreata* holotype w MCSN); Yarrabah (E. Mjöberg) (*daemeli exlex* holotype w NRMS); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.115) (w); Whitfield Ra. Environ. Park, 16°57'S, 145°42'E, 4.ii.1992 (H. Reichel) (w); Pine Ck CSIRO Tower, Yarrabah Rd, 16°59'S, 145°50'E,12.iv.1991 (GBM & HJ) (w); Bell Peak North, 20km S of Cairns, 17°05'S, 145°53'E, 16.ix.1981 (GBM & DJC) (w); Russell R., Bellenden Ker Landing, 17°16'S, 145°56'E, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w); Mission Bch, c. 2km W, 17°52'S, 146°05'E, 18-19.vii.1980 (RJK acc. 80.94) (w); Cardwell Ra., Murray R. Falls, 18°09'S, 145°49'E, 1-5.viii.1983 (RJK acc. 83.2) (w).

REMARKS. This species ranges from Torres Strait south to about Ingham, with additional records from the Northern Territory. It is common in coastal wetlands and *Melaleuca* swamps, but it has also been collected from the canopy of lowland tropical rainforest.

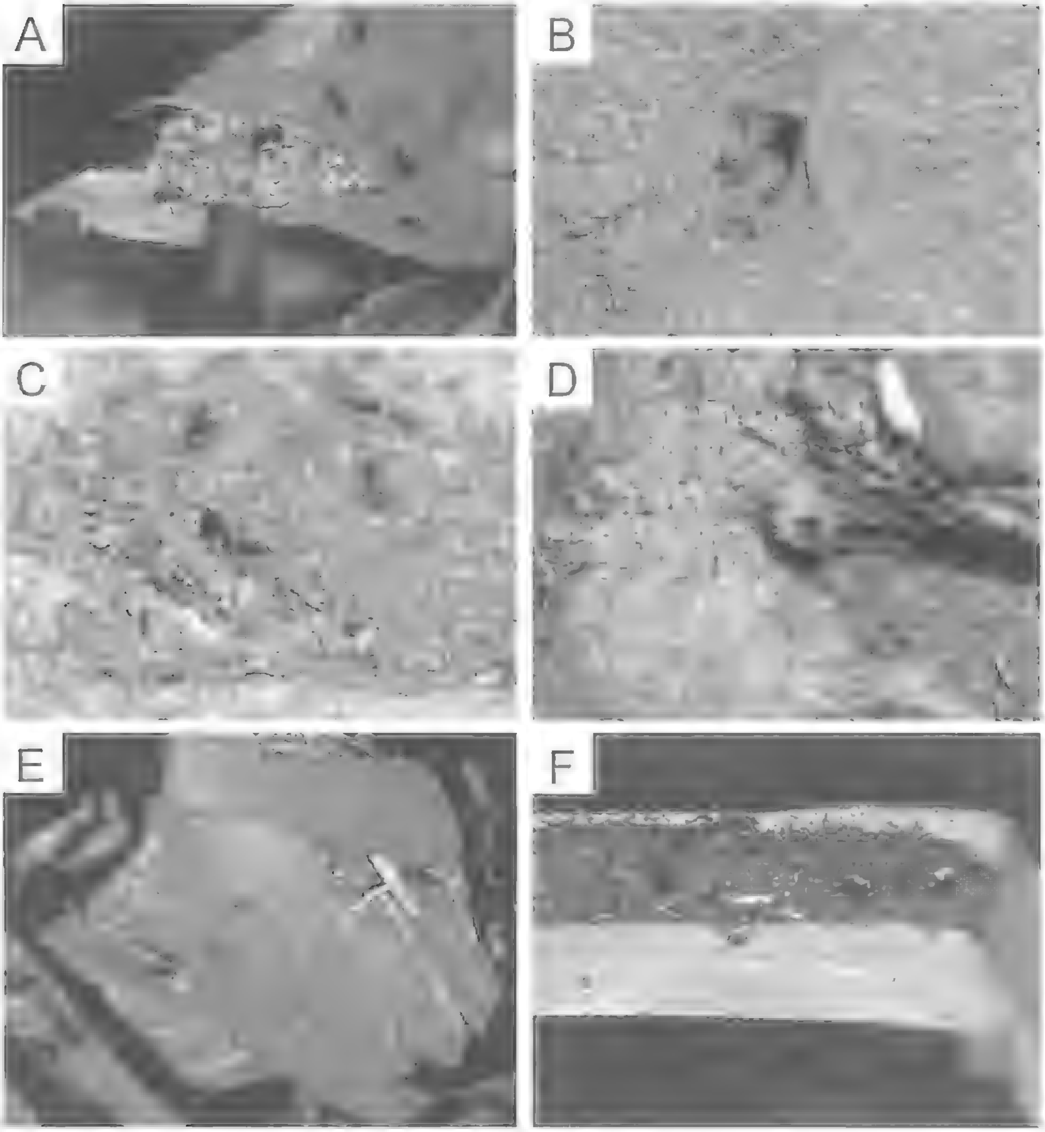

FIG. 3. Nests of Wet Tropics *Polyrhachis* species. A, *P. (Cyrtomyrma) yorkana;* B, *P. (Chariomyrma) sokolova*; C, *P. (Hagiomyrma) thusnelda*; D, *P. (Hedomyrma) turneri*; E, *P. (Myrmhopla) dives*; F, *P. (Myrmhopla) mucronata.*

Polyrhachis (Hedomyrma) daemeli
Mayr, 1876

Polyrhachis daemeli Mayr, 1876: 72.

MATERIAL. Hann Tbld Radar Stn, 16°55'S, 145°15'E, 950m, 26-27.xi.1998 (GBM) (w); Trinity Bch, 17km NNW of Cairns, 16°47'S, 145°41'E, 13.v.1974 (RJK acc. 74.27) (w); Walsh R. at Watsonville, 17°21'S, 145°19'E, 750m, 1.xii.1997 (GBM, DJC & CJB) (w); Cardwell Ra., Murray R. Falls, 18°09'S, 145°49'E, 1-5.viii.1983 (RJK acc. 83.3) (w); Paluma Ra., Hidden Valley, ix.1997 (B. Hoffman) (w).

REMARKS. This is a common species between Mackay and Brisbane, however records become somewhat sporadic towards the northern limits of its distribution.

Polyrhachis (Hedomyrma) erato Forel, 1902

Polyrhachis erato Forel, 1902: 512.
Polyrhachis aeschyle Forel, 1915: 111. Synonymy by Kohout, 1988b: 434.

MATERIAL. Atherton Tbld, N of Lake Tinaroo, c. 2500ft, 9.xi.1966 (RWT acc. 66.334) (w); Bartle Frere, S Peak summit, 17°24'S, 145°49'E, 1620m, 29.xi.1998 (GBM) (♀); Cedar Ck (E. Mjöberg) (*aeschyle* holotype w NRMS).

REMARKS. Besides the holotype of *P. aeschyle* only a short series of this species from Lake Tinaroo and a single dealate queen from the summit of South Peak of Bartle Frere are known from the Wet Tropics. Like the previous species, it is much more common and widespread in the south, from Mackay to Lamington NP on the Queensland-New South Wales border.

Polyrhachis (Hedomyrma) euterpe Forel, 1902

Polyrhachis euterpe Forel, 1902: 511.

MATERIAL. Dimbulah, 17°09'S, 145°07'E, 4.v.1990 (BBL) (w); Townsville, Pallarenda, 19°11'S, 146°46'E, 14.x.1981 (BBL) (w).

REMARKS. This is a rare species with a patchy distribution from northern to southern Queensland. It occupies savannah woodlands and open forests along the eastern slopes of the Great Dividing Range.

Polyrhachis (Hedomyrma) hermione Emery, 1895

Polyrhachis hermione Emery, 1895: 357.
(For full synonymy citations see Kohout, 1998: 514.)

MATERIAL. Kuranda, vi.1904 (F.P. Dodd) (w); Bellenden Ker (M. Podenzana) (*hermione* syntype w MCSN, MHNG); Kirrama Ra., c. 9km W of Kennedy, 18°12'S, 145°52'E, 29.ii.1996 (SKR #153) (w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, 100-500m, 9.xi.1984 (GBM) (w).

REMARKS. *Polyrhachis hermione* is a rare rainforest species only known from a few isolated collections within the Wet Tropics.

Polyrhachis (Hedomyrma) machaon Santschi, 1920

Polyrhachis (Hedomyrma) machaon Santschi, 1920: 568.

MATERIAL. Townsville, vi.1902 (F.P. Dodd) (*machaon* holotype w NHMB).

REMARKS. The unique holotype of *P. machaon* is the only specimen known from the Wet Tropics. All recently collected specimens originate from central and southern Queensland and northern New South Wales with the species apparently restricted to mangroves (De Baar & Hockey, 1987: 20).

Polyrhachis (Hedomyrma) mjobergi Forel, 1915

Polyrhachis (Hedomyrma) mjobergi Forel, 1915: 112.
Polyrhachis (Hedomyrma) anguliceps Viehmeyer, 1925: 148. Synonymy by Kohout, 1988b: 435.

MATERIAL. Kirrama Ra., nr JCU Field Stn, c. 600m, 18°11'S, 145°44'E, 4.vi.1996 (RJK acc. et al. 96.15) (w).

REMARKS. This is the only record of *P. mjobergi* from the Wet Tropics and considerably extends its known range. It was originally described from Lamington NP in southern Queensland and from Trial Bay (*anguliceps* Viehmeyer) in northern New South Wales. Its main distribution range extends from near Mackay south to Batemans Bay.

Polyrhachis (Hedomyrma) ornata Mayr, 1876

Polyrhachis ornata Mayr, 1876: 73.
Polyrhachis (Hedomyrma) humerosa Emery, 1921: 18. Synonymy by Kohout, 1988b: 435.
Polyrhachis (Hedomyrma) chrysothorax Viehmeyer, 1925: 148. Synonymy by Kohout, 1988b: 435.

MATERIAL. Windsor Tbld, SE, 16°16'S, 145°05'E, 850m, 9.ii.-17.v.1998 (GBM & DJC) (w).

REMARKS. A single specimen from Windsor Tbld significantly extends the range of this species. In the northern specimen the characteristic bright copper or brassy pubescence of the mesosomal dorsum is considerably less distinct, but in all other aspects it matches the abundant material of *P. ornata* from southern Queensland.

Polyrhachis (Hedomyrma) rufifemur Forel, 1907

Polyrhachis terpsichore var. *rufifemur* Forel, 1907: 41.
Polyrhachis terpsichore var. *elegans* Forel, 1910: 84. Synonymy by Kohout, 1988b: 436.

MATERIAL. Mt Spurgeon, 3km S, 16°27'S, 145°11'E, 19-23.xi.1997 (GBM, CJB & DJC) (w); Hann Tbld (Nth End), 16°49'S, 145°11'E, 1000m, 11-14.xii.1995 (GBM, GT & DJC) (w); Hann Tbld Radar Stn, 16°55'S, 145°15'E, 950m, 26-27.xi.1998 (GBM, P. Bouchard & A. O'Toole) (w); Bakers Blue Mtn, 17km W of Mount Molloy, 16°42'S, 145°09'E, 12.ix.1981 (GBM & DJC) (w); Kuranda, nr Cairns (R. Turner) (*terpsichore elegans* syntype w MHNG); Millstream Cons. Park, 17°32'S, 145°29'E, 1040m, 6.xii.1998-4.ii.1999 (GBM & DJC) (w).

REMARKS. As indicated earlier (Kohout, 1988b: 436), specimens of the northern populations (*terpsichore elegans*) tend to be larger with less distinct and more diluted pubescence than specimens from southeast Queensland and New South Wales.

Polyrhachis (Hedomyrma) thais Forel, 1910

Polyrhachis thais Forel, 1910: 86.

MATERIAL. Kuranda, nr Cairns (R. Turner) (*thais* syntype w MHNG); Mission Bch, 17°52'S, 146°06'E, 29.ii.1996 (SKR #226, 227) (w); Sth Mission Bch, 2km NbyW, 17°55'S, 146°05'E, 18-19.vii.1980 (RJK acc. 80.80) (w); Kirrama Ra., 18°11'S, 145°52'E, 19.ii.2000 (RJK acc. 2000.4) (w); Wallaman Falls, 18°35'S, 145°48'E, 28.ix.1987 (RJK acc. 87.101) (w); Crystal Ck NP, 18°59'S, 146°09'E, 330m, 11.i.1977 (BBL) (w, ♀); Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM, GT & S. Hamlet) (w).

REMARKS. This is a relatively rare rainforest species apparently endemic to the Wet Tropics.

Polyrhachis (Hedomyrma) turneri
Forel, 1895
(Figs 2F, 3D)

Polyrhachis turneri Forel, 1895: 45.

MATERIAL. Black Mtn, NW base, 15°40'S, 145°13'E, 10.vi.1996 (CJB) (w); Hann Tbld (Nth Base), 16°48'S, 145°12'E, 500m, 11-14.xii.1995 (GBM, GT & DJC) (w); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.115) (w); Bakers Blue Mtn, 17km W of Mount Molloy, 16°42'S, 145°09'E, 12.ix.1981 (GBM & DJC) (w); Wallaman Falls, 18°35'S, 145°48'E, 28.ix.1987 (RJK acc. 87.102) (w); Paluma Ra., Hidden Valley, xi.1997 (B. Hoffman) (w); Mt Stuart, Townsville, 19°21'S, 146°47'E, 12.iii.1993 (GBM) (w); Hervey Ra., Turtle Rock area, 19°24'S, 146°31'E, 24.ix.1995 (SKR #16) (w); Mt Elliot NP, Alligator Ck, 19°26'S, 146°57'E, 11.vi.1987 (RJK acc. 87.90) (w).

REMARKS. *Polyrhachis turneri* is known from Torres Strait south to Mackay. It selects rock crevices in which to build its nests which are characterised by pure white, tubular, silken entrances.

Polyrhachis (Hedomyrma) sp.
('*Hedo* 05')

MATERIAL. Mt Cook NP, 15°29'S, 145°16'E, 430m, 9.xi.1995 (GBM, DJC & HJ) (w); East Normanby R., 15°53'S, 145°12'E, 540m, 31.xii.1990 (GBM & ANZSES Exp.) (w); Downey Ck, 17°40'S, 145°47'E, c. 400m, 7.vii.1971 (RWT acc. 71.1136) (w); Wallaman Falls Rd Junct., 18°39'S, 145°52'E, 650m, 5.ii.1996 (GBM) (w).

REMARKS. This is a rare, rainforest or wet sclerophyll forest species, collected only occasionally by sweeping and beating low foliage or by pyrethrum spraying. Known distribution is patchy and extends from Mt Cook near Cooktown south to Cooloola NP north of Brisbane.

Polyrhachis (Hedomyrma) sp.
('*Hedo* 07')

MATERIAL. Mt Cook NP, 15°29'S, 145°16'E, 430m, 9.xi.1995 (GBM, DJC & HJ) (w); Mt Hartley, 15°46'S, 145°19'E, 500-700m, 11.vi.1996 (CJB) (w); Cape Tribulation, 16°05'S, 145°28'E, 29.xii.1983-8.i.1984 (GBM) (w); Oliver Ck, c. 8km SW of Cape Tribulation, 16°08'S, 145°26'E, 14.vi.1996 (RJK acc. 96.53) (w); Kuranda, 16°49'S, 145°38'E, 10-20.vii.1976 (P. Filewood) (w); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.115) (w); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°54'E, 17-24.x.1981 (GBM & Earthwatch Exp.) (w); Josephine Falls, 17°26'S, 145°51'E, 12.ii.1996 (GBM) (w); Eubenangee Swamp, nr Innisfail, 17°27'S, 145°58'E, <100ft, 4.xi.1966 (RWT acc. 66.257) (w); Palmerston NP, 350-400m, 2.i.1990 (GBM) (w); Sth Mission Bch, 2km Nby W, 17°55'S, 146°05'E, 18-19.vii.1980 (RJK acc. 80.80).

REMARKS. This species superficially resembles *P. thais* Forel but differs in a number of characters, including distinctly longer pronotal spines that in *P. thais* are reduced to more-or-less pointed angles. The distribution of both species is apparently limited to the Wet Tropics.

Polyrhachis (Hedomyrma) sp.
('*Hedo* 09')

MATERIAL. Mt Elliot NP, North Ck, 500-800m, 2.xii.1986 (GBM, GT & S. Hamlet) (w, ♀); Mt Elliot NP, St Margaret Ck, 19°30'S, 146°59'E, 23.ix.1995 (SKR #8) (w)

REMARKS. This spectacular species appears to be restricted to Mt Elliot NP.

Polyrhachis (Hedomyrma) sp.
('*Hedo* 13')

MATERIAL. Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996 (CJB) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°26'E, 12-15.vi.1996 (RJK et al. acc. 96.47) (w); Cape Tribulation, 16°05'S, 145°28'E, 19.x.1980 (GBM) (w); Hann Tbld, 16°55'S, 145°15'E, 950m, 26-27.xi.1998 (GBM) (w); Daintree, 4mi S, 29.x.1966 (RWT acc. 66.122) (w); Caravonica, 10km NW of Cairns, 16°51'S, 145°41'E, 19.ii.2000 (RJK acc. 2000.8) (w); Etty Bay, 7km ESE of Innisfail, 17°35'S, 146°05'E, 23.vii.1980 (RJK acc. 80.157) (w); Mission Bch, 2km W, 17°52'S, 145°05'E, 18-19.vii.1980 (RJK acc. 80.93) (w); Kirrama Ra., 18°11'S, 145°52'E, 19.ii.2000 (RJK acc. 2000.4) (w).

REMARKS. This species resembles *P. cleopatra*, but differs in a number of characters. These include the first gastral tergite which is smooth and shining with only a weak indication of a lateral process. In *P. cleopatra* the first gastral tergite is intensively longitudinally sculptured with a very distinct lateral process. This is predominantly a rainforest species and appears endemic to the Wet Tropics.

Subgenus **Myrma** Billberg, 1820
Polyrhachis relucens species-group

Polyrhachis (Myrma) foreli Kohout, 1989
(Fig. 4F)

Polyrhachis foreli Kohout, 1989: 510.
'*Polyrhachis (Myrma) relucens* r. *andromache* var. *andromeda*' Forel, 1915: 110.
'*Polyrhachis (Myrma) relucens andromache andromeda*' Forel; Taylor, 1986: 34. Unavailable name.

MATERIAL. Helenvale, 15°42'S, 145°13'E, 10-20.vii.1976 (P. Filewood) (w); Home Rule, 15°45'S, 145°17'E, 9-11.vi.1996, c. 200m (RJK et al. acc. 96.43) (w); Mt Hartley, 15°46'S, 145°19'E, 200-500m, 11.vi.1996 (CJB) (w); Shiptons Flat, 35km S of Cooktown, 15°48'S, 145°16'E, 22.iv.1982 (GBM) (w); Mt Finnigan, via Helenvale, 15°50'S, 145°16'E, 19-21.iv.1982 (GBM) (♀); Gap Ck, Twelve-Mile Scrub, 15°50'S, 145°19'E, 27.xi.1975 (V. Davies & R. Monroe) (w); Emmagen Ck, 16°03'S, 145°27'E, 19-28.ix.1982 (GBM, D. Yeates, GT) (w); Pilgrim Sands, c. 1kmNW of Cape Tribulation, 16°04'S, 145°28'E, 12-15.vi.1996 (RJK et al. acc. 96.47) (w); Cape Tribulation, 16°05'S, 145°28'E, 29.xii.1983-8.i.1984 (GBM) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK accs 2000.18, 21, 22, 28) (w, ♀); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22.-24.vii.1980 (RJK acc. 80.119) (w); Bell Peak North, 20km S of Cairns, 17°05'S, 145°53'E, 16.ix.1981 (GBM & DJC) (w); Bellenden Ker (E. Mjöberg) ('*relucens andromache andromeda*' w MHNG, NRMS) ; Russell R., Bellenden Ker Landing, 17°16'S, 145°54'E, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w); Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996 (RJK et al. acc. 96.29) (w, ♀, ♂); Etty Bay, 29.ix.1996 (JPH) (♀); NE Tully, nr Clump Point, 17°52'S, 146°07'E, 30.iv.1969 (RWT acc. 69.123) (*foreli* holotype & paratype w, ♀, ♂); Sth Mission Bch, c. 6km W, 17°56'S, 146°02'E, 18-19.vii.1980 (RJK acc. 80.60) (*foreli* paratype w); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, 100-500m, 8-18.xi.1984 (GBM) (w).

REMARKS. This species ranges from New Guinea south through Cape York Pen. to the Wet Tropics. It is a rainforest species commonly nesting in rotting logs or in the ground (Kohout, 1989: 510; 1998: 521).

Subgenus **Myrmatopa** Forel, 1915

Polyrhachis (Myrmatopa) lombokensis Emery, 1898
(Fig. 4H)

Polyrhachis lombokensis Emery, 1898: 239.
Polyrhachis (Myrmatopa) lombokensis var. *yarrabahensis* Forel, 1915: 115.
Polyrhachis yarrabahensis Forel; Kohout & Taylor, 1990: 520. Raised to species.
Polyrhachis yarrabahensis Forel; Bolton, 1995: 359; Dorow, 1995: 45. Syn. nov.

MATERIAL. Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK et al.accs 96.41, 49, 50) (w, ♀); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 12-15.vi.1996 (RJK et al. acc. 96.50) (w); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK acc. 2000.37) (w); Kamerunga, 10km NW of Cairns, 16°53'S, 145°41'E, 13.vii.1960 (G.W. Saunders) (w); Yarrabah (E. Mjöberg) (*yarrabahensis* syntype w MHNG, NRMS); Yarrabah, c. 11km E of Cairns, 16°56'S, 145°52'E, 22-24.vii.1980 (RJK accs 80.125, 126, 127, 133, 135, 136, 137, 144, 145, 148, 151) (w, ♀); Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996 (RJK et al. acc. 96.24) (w); Canal Ck, nr Innisfail, 23.v.1993 (L.R. Ring) (w, ♀).

REMARKS. When Kohout & Taylor (1990) raised *P. (Myrmatopa) lombokensis yarrabahensis* to specific status they noted that the characters separating both taxa were relatively slight, but seemingly constant. They were hesitant to synonymize both names because of the great distance separating their respective distribution ranges with no material known to them from the intermediate areas. However, after examining the remaining specimens of Emery's syntype series, which has only recently become available, I now regard both forms synonymous. The characters listed by Kohout & Taylor seem to integrate and I have no hesitation in considering *P. yarrabahensis* and *P. lombokensis* isolated populations of a single biological species. The distribution of this species in Australia is centred on the Wet Tropics, with only a single additional record from Massey Spur Ck on Cape York Pen. (J.L. Wassell). Its occurrence in Papua New Guinea has also been recently confirmed by discovery of a single series collected on Misima I. (Rev. H.K. Bartlett).

Subgenus **Myrmhopla** Forel, 1915
Polyrhachis dives species-group

Polyrhachis (Myrmhopla) dives Fr. Smith, 1857
(Figs 3E, 4G)

Polyrhachis dives Fr. Smith, 1857: 64.
Polyrhachis (Myrmhopla) exulans Clark, 1941: 91. Synonymy by Kohout, 1988b: 433.
(For full synonymy citations see Bolton, 1995: 347).

MATERIAL. Yarrabah, c. 11km E of Cairns, 16°56'S, 145°52'E, 22-24.vii.1980 (RJK accs 80.113, 130, 141) (w, ♀, ♂); South Mission Bch, 2km NbyW, 17°55'S, 146°05'E, 13.vi.1980 (RJK accs 80.14, 15, 17, 18) (w, ♀).

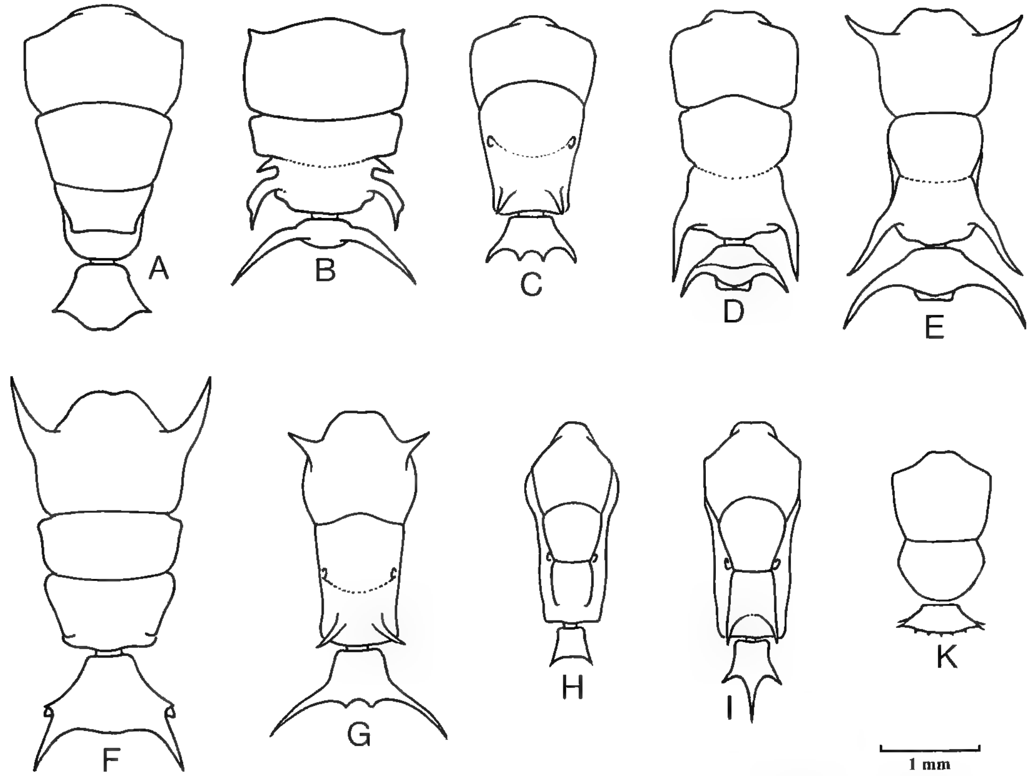

FIG. 4. *Polyrhachis* spp, dorsal view of mesosoma and petiole in outline (pilosity omitted): A, *P. (Campomyrma) creusa*; B, *P. (Chariomyrma) schoopae*; C, *P. (Cyrtomyrma) australis*; D, *P. (Hagiomyrma) penelope*; E, *P. (Hedomyrma) cupreata*; F, *P. (Myrma) foreli*; G, *P. (Myrmhopla) dives*; H, *P. (Myrmatopa) lombokensis*; I, *P. (Myrmothrinax) queenslandica*; K, *Echinopla australis*.

REMARKS. This is a widespread species, ranging from south-east Asia south to northern Australia, where it is known from two, widely separated populations, one around Darwin in the Northern Territory and the other in North Queensland, where it ranges from Cairns south to about Mission Beach. It prefers open woodlands and swampy coastal plains.

Polyrhachis mucronata species-group
Polyrhachis (Myrmhopla) mucronata
Fr. Smith, 1859
(Fig. 3F)

Polyrhachis mucronatus Fr. Smith, 1859: 140.

MATERIAL. Mt Hedley, 1-2km N of Home Rule, 15°45'S, 145°17'E, 200-300m, 11.vi.1996 (RJK et al. acc. 96.44) (w); Cedar Bay NP, 15°48'S, 145°19'E, 16.vi.1997 (SKR #589) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°28'E, 12-15.vi.1996 (RJK et al. acc. 96.47) (w); Cape Tribulation NP, 16°04'S, 145°27'E, 6.xii.1985 (RJK acc. 85.5) (w, ♀); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK accs 2000.17, 21) (w, ♀); McLean Ck, c. 19km SbyW of Cape Tribulation, 16°15'S, 145°26'E, 15.vi.1996 (RJK acc. 96.54) (w); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°54'E, 17-24.x.1981 (GBM & Earthwatch Exp.) (w); Russell R., Bellenden Ker Landing, 17°16'S, 145°56'E, 1-9.xi.1981 (GBM & Earthwatch Exp.) (w); Josephine Falls, 17°26'S, 145°51'E, 12.ii.1996 (GBM) (w); Seymour Ra., c. 7km N of Innisfail, 17°28'S, 146°01'E, <100m, 5-6.vi.1996 (RJK et al. 96.31) (w, ♀); Mission Bch, 17°45'S, 146°00'E, 10m, 20.i.1996 (SKR #101) (w); Dunk I., 17°57'S, 146°09'E, viii.1927 (H. Hacker) (♀); Hinchinbrook I., Gayundah Ck, 18°21'S, 146°14'E, 100-500m, 8-18.xi 1984 (GBM) (w).

REMARKS. *Polyrhachis mucronata* ranges from eastern Indonesia and New Guinea south to northern Queensland. The specimens from Australia and New Guinea differ somewhat from the holotype and other available material from Indonesia, however, for the purpose of this paper I regard them as a different populations of a single biological species. It is a common arboreal species in the monsoon rainforests of Cape York Pen. and the lowland rainforests of the Wet Tropics where it reaches the southern limit of its distribution.

Polyrhachis viehmeyeri species-group

Polyrhachis (Myrmhopla) rustica Kohout, 1990

Polyrhachis rustica Kohout, 1990: 505.

MATERIAL. Chewko Rd, SW of Mareeba, 17.vi.1961 (L.H. Weatherill) (*rustica* paratype w BMNH).

REMARKS. The holotype of this species was described from Collinsville and the above specimen represents the only record from the Wet Tropics. These ants apparently co-exist in the nests of other ants, namely *Rhytidoponera* spp. (Kohout, 1990:499-508) and this behaviour is presently under investigation by Drs Alfred Buschinger (Darmstadt) and Ulrich Maschwitz (Frankfurt am Main) (pers. comm.).

Subgenus **Myrmothrinax** Forel, 1915

Polyrhachis (Myrmothrinax) delicata Crawley, 1915

Polyrhachis delicata Crawley, 1915: 238.
Polyrhachis (Myrmothrinax) lysistrata Santschi, 1920: 569. Synonymy by Kohout, 1994: 135.

MATERIAL. Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK et al.accs 96.37, 38, 42, 43) (w, ♀); Mt Finlay, Fritz Ck, 15°50'S, 145°21'E, 5.xii.1975 (V. Davies & R. Monroe) (♀); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 20-21.ii.2000 (RJK acc. 2000.38) (w); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK accs 80.124, 128, 139, 140, 142, 143) (w, ♀, ♂); Mission Bch, 2km W, 17°52'S, 146°05'E, 18-19.vii.1980 (RJK acc. 80.88) (w); Townsville, 30.iv.1902 (F.P. Dodd) (*lysistrata* syntype w NHMB).

REMARKS. This species ranges from the Northern Territory to north Queensland, as far south as Townsville. Like the following species, it is an arboreal nesting ant, building its polydomous nests upon the leaves of trees along the edges of lowland tropical rainforests.

Polyrhachis (Myrmothrinax) queenslandica Emery, 1895 (Fig. 4I)

Polyrhachis queenslandica Emery, 1895: 356.

MATERIAL. Kamerunga (M. Podenzana) (*queenslandica* syntype w MCSN, MHNG); Bellenden Ker, Cableway Base Stn, 17°16'S, 145°54'E, 17.-24.x.1981 (GBM & Earthwatch Exp.) (w); Canal Ck, nr Innisfail, 23.v.1993 (L.R. Ring) (w, ♀, ♂); Sth Mission Bch, c. 6km W, 17°56'S, 146°02'E, 18-10.vii.1980 (RJK accs 80.68, 69, 71, 72, 73, 74) (w).

REMARKS. This species ranges south from New Guinea to northern Queensland. Its nesting habits are identical to the closely related *P. delicata*, however, *P. queenslandica* is much less common.

Genus **Echinopla** Fr. Smith, 1857

Echinopla australis Forel, 1901 (Fig. 4K)

Echinopla australis Forel, 1901b: 75.

MATERIAL. Mt Hedley, Home Rule, 15°45'S, 145°17'E, c. 200m, 9-11.vi.1996 (RJK et al. acc. 96.43) (w); Pilgrim Sands, c. 1km NW of Cape Tribulation, 16°04'S, 145°26'E, 12-15.vi.1996 (RJK et al. acc. 96.51) (w, ♂); Canopy Crane site, Cape Tribulation, 16°06'S, 145°27'E, 9.ii.2000 (N. Blüthgen #3049) (w); Mossman Bluff Track, 5-10km W of Mossman, c. 16°28'S, 145°19'E, 1-16.i.1990 (GBM, GT & ANZSES) (w); Yarrabah, c. 9km E of Cairns, 16°54'S, 145°51'E, 22-24.vii.1980 (RJK acc. 80.120) (w); ditto, 1.iii.1996 (SKR #164) (w); Mulgrave R., Deeral Landing, 17°13'S, 145°55'E, 4.viii.1975 (tall mangroves) (BBL) (w); Etty Bay, 7km ESE of Innisfail, 17°33'S, 146°05'E, 23.viii.1980 (RJK acc. 80.155) (w); Palmerston NP, 17°37'S, 145°40'E, 400m, 4.v.1997 (SKR) (w); Crystal Ck NP, nr Paluma, 19°00'S, 146°13'E, 11.i.1977 (BBL) (w); Cape Cleveland, c. 30km N of Giru, 8.ix.1980 (BBL) (w).

REMARKS. *Echinopla australis* is predominantly a rainforest species. However a colony from Pilgrim Sands was nesting in a dry hollow seedpod of *Calophyllum inophyllum* on the beach front. It occurs from New Guinea south to near Mackay.

Echinopla turneri Forel, 1901

Echinopla turneri Forel, 1901b: 76.
Echinopla turneri var. *pictipes* Forel, 1901b: 76. Synonymy by Taylor, 1992: 61.

MATERIAL. Crystal Creek NP, nr Paluma, 19°00'S, 146°13'E, 11.i.1977 (BBL) (w); Mt Elliot NP, Pangola Park, 30.v.1980 (BBL) (w); Mt Elliot NP, St Margaret Ck, 3.xii.1980 (BBL) (w, ♀).

REMARKS. *Echinopla turneri* is also a rainforest species, nesting mostly in hollow twigs and small branches. It ranges from the Paluma Ra. south to Yeppoon. Distinguishing characters of both *Echinopla* species, together with notes on their distribution and biology, were given by Taylor, 1992: 60-61.

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CLIDICUS ABBOTENSIS O'KEEFE, A NEW SPECIES OF SCYDMAENIDAE (COLEOPTERA: STAPHYLINOIDEA) FROM AUSTRALIA WITH DESCRIPTION OF THE LARVA

SEAN T. O'KEEFE AND G.B. MONTEITH

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Clidicus abbotensis O'Keefe sp. nov. (Coleoptera: Scydmaenidae) (type locality: Mt Abbot, Queensland, Australia) is described from both adults and larvae. Mouthparts of adults and larvae, male and female genitalia, and general body morphology of adults and larvae are described and illustrated. The known distribution of *Clidicus* Laporte is extended over 3,500km from Java and Borneo to northeastern Australia. A catalogue and key to all *Clidicus* species is included. ☐ *Coleoptera, Scydmaenidae, Clidicus, Australia, taxonomy, biogeography, catalogue, larval morphology.*

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The Indomalayan genus *Clidicus* Laporte has the largest Scydmaenidae in the world, with species up to 10mm (*C. grandis* Laporte) in length. This is an extraordinary size considering that the body length for nearly all other genera is under 2mm. To date, the genus includes 11 described recent species, and one from Baltic amber. With the possible exception of *Leptomastax* Pirazzoli, *Clidicus* has received more published attention than any other genus of Scydmaenidae. However, of the numerous articles on the genus, only Wasmann (1896) intended his as a thorough revision, briefly reviewing the literature and recognising only three species: *C. formicarius* Pascoe, *C. grandis* and *C. taphrocephalus* Gestro. A fourth species, *C. monstrosus* (Walker), was not dealt with by Wasmann, but was included in the world catalogue of Scydmaenidae (Csiki, 1919). Since Wasmann's revision eight additional species have been described. *Clidicus balticus* was described by Schaufuss (1896) from Baltic amber and is of considerable interest because of its implications for scydmaenid biogeography. The remaining seven species were described by Pic (1928), Lhoste (1937a, 1937b, 1939) and Besuchet (1971). Pic (1928) published a short description for *C. laticeps* from Indonesia. Lhoste (1937a) described the first *Clidicus* from the Asiatic mainland (*C. tonkinensis*, Vietnam) and redescribed it as a new species in his 1937b paper. This latter paper is a brief review of *Clidicus* with a key to the six species known then. It also included a habitus illustration for *Clidicus* and figures of the male aedeagi for *C. grandis* and *C. tonkinensis*. Later, Lhoste (1939) described *C. mysorensis* from India and *C. termitophilus* from Borneo and included figures of the male aedeagi for both. Besuchet (1971) revised the Sri Lankan species of *Clidicus*. He examined the type material of *C. monstrosus* and described three new species: *C. mussardi* Besuchet, *C. loebli* Besuchet and *C. quadricollis* Besuchet. Besuchet illustrated the aedaegus of *C. mussardi*, the ovipositor of *C. loebli* and *C. mussardi*, and the spermatheca of all four species.

In this paper we describe a new species from an isolated mountain top in northeastern Australia. It includes the first description of a larva in the Clidicini and the first figures and descriptions of mouthparts and general body morphology. We discusses the disjunct distribution of this species from other *Clidicus*. Authorship of the new species is attributed to S.T. O'Keefe.

DISCOVERY OF *CLIDICUS* IN AUSTRALIA

Mount Abbot is an isolated and inaccessible mountain which rises abruptly to 1,056m from a flat coastal plain about 60km inland from the coastal town of Bowen at 20°05'S in tropical north Queensland (Fig. 5C). Geologically it is a granitic batholith exposed by weathering (Paine & Cameron, 1972) and has extensive areas of exposed rocky slopes and domes giving it a biologically depauperate appearance when viewed from a distance.

Although Mt Abbot lies within three large private grazing properties whose joint boundaries intersect near its summit, it is not used for grazing and has apparently never been climbed by its owners. Rough vehicle access to its base is possible at several points and from there the summit can be reached by a 5-6 hour walk. The first known biological observations of the upper parts of the mountain are as recent as 1992 when botanist A.R. Bean, of the Queensland Herbarium, surveyed the vegetation during 5 solo ascents, totalling 12 days. He reported a pristine wilderness with a diverse vascular flora of 493 species including 4 new species and numerous major range extensions and disjunctions (Bean, 1994). The flora included only 11 introduced weed species. Bean described 7 vegetation types of which 3 predominated above about 700m. These were montane heath on rock pavements where soils were thin, wet sclerophyll forest where soils were deep, and very limited occurrence of rainforest as narrow strips along some of the higher altitude gullies.

Subsequently, two Queensland Museum parties, including the junior author, made faunal collections in December 1996 (3 days) and April 1997 (4 days). They found an exciting relict native fauna, and an apparent absence of feral animals (cattle, horses, goats, pigs, rabbits, cane toads), which detract from the wilderness values of many other mountain areas in north Queensland. The topography of Mt Abbot and collecting sites are shown in Fig. 5B.

During the December visit (dry season), two specimens of a large, ant-like, unrecognised beetle were taken on the underside of a piece of wood lying on the ground in fringing rainforest at 750m in the gully called 'Big Gully' by Bean. A third was taken by pyrethrum spraying of tree bases in a patch of *Livistona* palms and rainforest shrubs at 850m in the saddle immediately east of the summit. The specimens were found to belong to the family Scydmaenidae but were 4 times the length of any species previously known from Australia. On submission to the senior author they were identified as belonging to the genus *Clidicus*, being the first record of the Tribe Clidicini from east of Wallace's Line, and some 3,500km beyond its known range (Fig. 5A).

On return to Mt Abbot the following April (end of wet season), another search was made for the species. It was found to be common in the original gully, for which the more appropriate name of 'Scyd Gully' was proposed, and 108 specimens were taken in a few hours. Twenty-three specimens were also taken in the open wet sclerophyll vegetation, but only above about 950m altitude on the shoulder to the immediate west of the absolute summit and on the summit of the secondary summit knoll which is 500m east of the true summit. It was not detected during 3 days in similar habitat at the 800m camp 1.5km east of the summit, nor was it taken in heath vegetation. The species seems to be confined to an area of perhaps 1-2km^2 around the summit and extending slightly down the damper upper part of Scyd Gully. This may be controlled to some extent by the incidence of clouds which often enveloped the summit but not down to the altitude of the camp. Frequent summit cloud generates a specialised environment for insects on other north Queensland mountains (Monteith, 1985).

Clidicus abbotensis O'Keefe, sp. nov.
(Figs 1-4)

MATERIAL. Holotype. ♂, Qld, Mt Abbot (20°06'S, 147°45'E), RF Gully, 750m, 10.iv.1997, Monteith, Cook and Janetzki (Queensland Museum, Brisbane, QMT 62985). Paratypes (98). All Mt Abbot: 1 ♂ 2 ♀, summit area, 750-1000m, 8-10.xii.1996, G. Monteith, D.& I. Cook; 2 ♂ 2 ♀, RF Gully, 750m, 10.iv.1997, G. Monteith, pyrethrum [fogging of] trees, and rocks; 37 ♂ 30 ♀, same locality, Monteith, Cook, Janetzki; 6 ♂ 16 ♀, 800-1000m, 9-12.iv.1997, Monteith, Cook, Janetzki; 1 ♂ 1 ♀, summit shoulder, 1,000m, 11.iv.1997, Monteith, pyrethrum [fogging of] trees. Paratype adults deposited in California Academy of Sciences, San Francisco; Essig Museum of Entomology, Berkeley; Field Museum of Natural History, Chicago; Museum of Comparative Zoology, Harvard University, Cambridge; United States National Museum, Washington DC; Texas A & M University Collection, College Station, Texas; Australian National Insect Collection, Canberra; The Natural History Musem, London; Natural History Museum, Geneva; Queensland Museum, Brisbane, and S.T. O'Keefe collection. Larvae (7) are deposited in Queensland Museum, Field Museum, and S.T. O'Keefe collection.

DIAGNOSIS. *Clidicus* can be distinguished from other Scydmaenidae by large size (4-10mm) or by the combination of characters: antennomere I 7-8 × as long as wide; vertex at least twice as wide as long, with shallow to deep posterior impression; and pronotum strongly convex, rounded, with posterior collar. *Clidicus abbotensis* differs from other species of *Clidicus* by its disjunct range in Queensland, Australia, instead of Indonesia to Sri Lanka or by the combination of characters: head dark brown, pronotum and elytra light reddish-brown, and antennae half as long as body (measured as antennomeres II-XI).

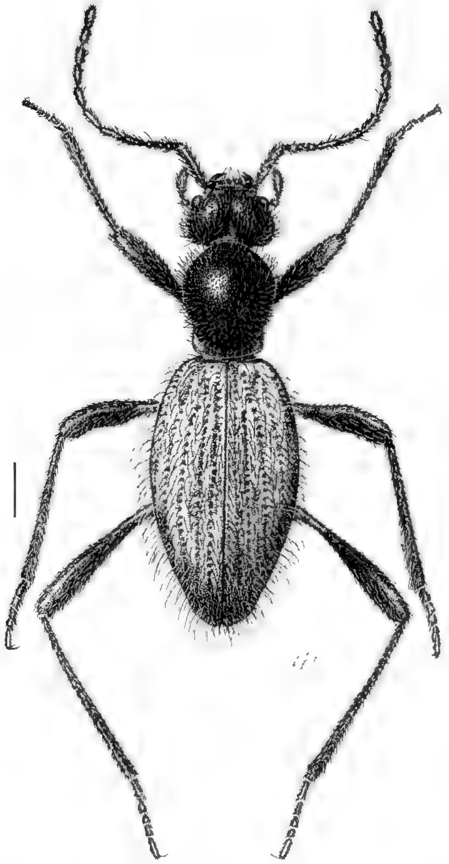

FIG. 1. *Clidicus abbotensis* O'Keefe, sp. nov., ♂, dorsal view. Scale bar = 1.00mm.

DESCRIPTION. ADULTS. Males 7.1-8.7mm long (mean = 7.9mm), females 6.7-7.6mm long (mean = 7.1mm); head dark brown, pronotum and elytra light reddish brown; setation moderately dense, strongly erect.

Head. (Fig. 3A-B) 1.3-1.7mm wide for males (mean = 1.6mm), 1.4-1.7mm wide for females (mean = 1.5mm); vertex 1.1-1.3mm long for males (mean = 1.2mm), 1.0-1.1mm long for females (mean = 1.1mm), distinctly wider than long; vertex 2.5 × as wide as long, with slight medial subtriangular depression at posterior margin; distinct ridge between clypeus and frons; frontoclypeal region flat, broad; occiput (oc) distinctly narrower than rest of head, sharply constricted from vertex, half as wide as head width at eyes, 1/4 length of entire head from frons to posterior of occiput; gular plate (gp – posterior and medial to posterior tentorial pits) fused to head, anterior margin fused with submentum (smt), posterior margin indistinct from occiput; posterior tentorial pits narrowly separated; submentum (smt) subtriangular, broad, narrowed posteriorly; hypostomal suture (hs) distinct; hypostomae (hy = crassa of Blackwelder, 1936) present, elongate, extended from submentum to clypeus; eyes relatively small, circular in outline, strongly convex, finely faceted, positioned just anterior to middle of head, at level of and posterior to antennal insertions; antennae (Fig. 3I) half body length (Figs 1, 2A), antennal insertions widely separated, exposed, medial to compound eyes; antennomere I elongate, 8 × as long as wide at widest point, apex emarginate; II twice as long as wide, slightly widened at distal end; III-VIII at least twice as long as wide, subcylindrical to slightly and gradually expanded at distal end, moderately covered with long, erect setae; III nearly twice as long as II; IV-VII subequal in size and shape, 2.5 × as long as wide; IX-XI each slightly wider than any of the preceding antennomeres, densely covered with both long and short erect setae.

Mouthparts. (Fig. 2B-E). Labrum (Fig. 2B) 1.5 × as wide as long, basal margin biemarginate, lateral margins convexly rounded, distal margin sinuate with deep median emargination, with 2 pairs of medial and 3 pairs of lateral setae; mandible (Fig. 2C) subtriangular, base broad, convex, apex recurved with 2 apical and 2 subapical teeth, prostheca (prth) with short setae from base of subapical tooth to near base of mandible, with 3 sensory setae; maxilla (Fig. 2D) with relatively small triangular stipes (st), subtriangular palpifer (plf), elongate galea (ga), and elongate lacinia (lc), palpus greatly enlarged, palpomere II elongate, slender, curved, with length 5 × width, palpomere III elongate, abruptly expanded at distal end, 4 × as wide at apex as at base, as long as palpomere II, paplomere IV subconical, half as long as palpomere III; labium (Fig. 2E) with mentum (mt) transverse, width 2.5 × length, rectangular, palpomere I moderate in size, subquadrate, with single elongate seta each on inner and outer apical margins, palpomere II elongate, length 3 × width, widest slightly before apex, with several moderate long and short setae along lateral margin and apex, palpomere III elongate, length 3-4 × width of base, nearly half length of II, apex pointed.

Prothorax. (Fig. 3C-D). Pronotum slightly longer than wide, 1.8-2.2mm long for males (mean = 2.0mm), 1.6-2.1mm long for females (mean =

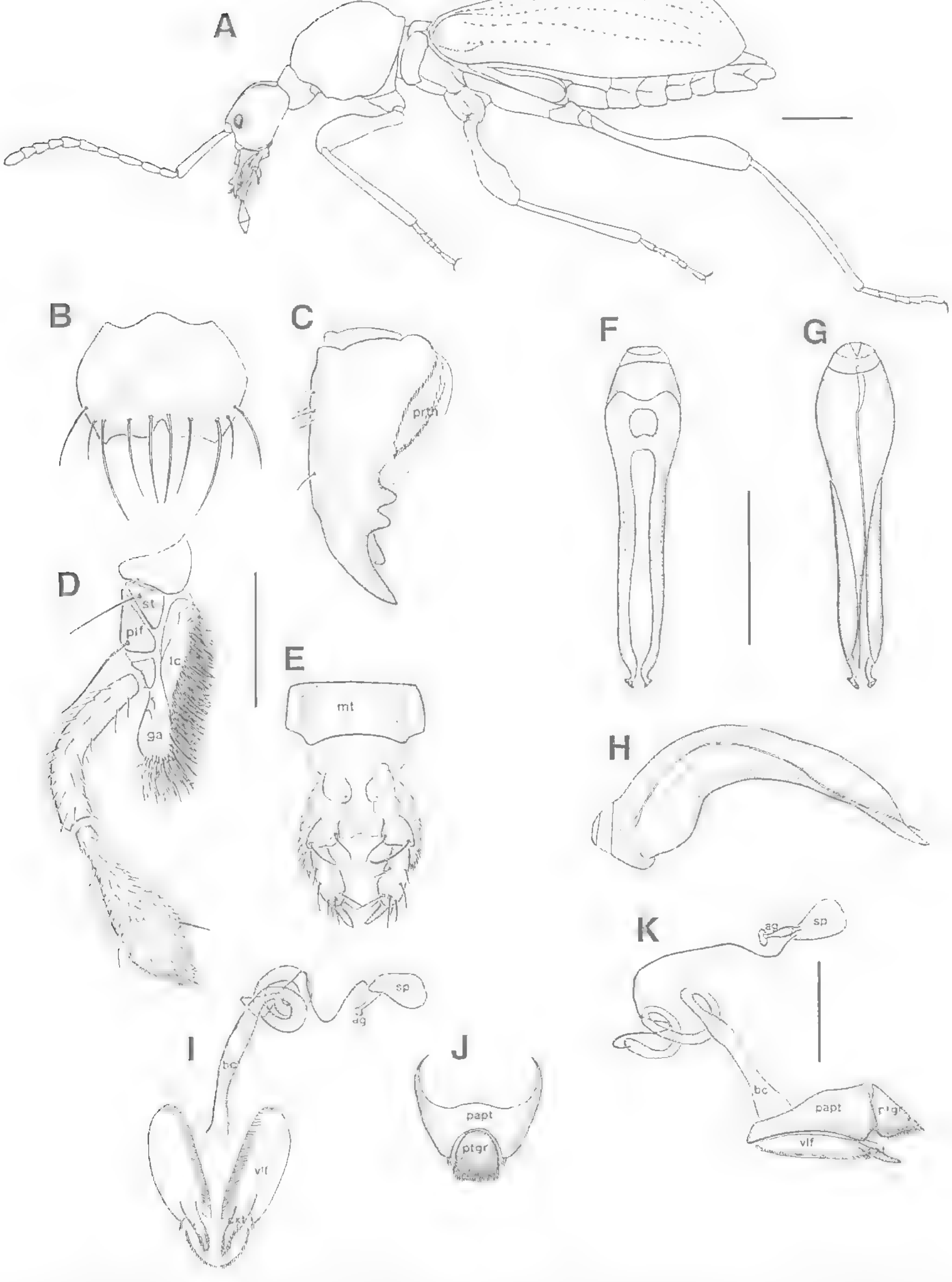

FIG. 2. *Clidicus abbotensis* O'Keefe. A, ♀, left lateral view; B, labrum, anterior view; C, right mandible, anterior view; D, right maxilla, anterior view; E, labium, ventral view; F, ♂ aedeagus, dorsal view; G, aedeagus, ventral view; H, aedeagus, left lateral view; I, ♀ ovipositor, dorsal view; J, ovipositor, ventral view; K, ovipositor, right lateral view. ag = accessory gland, bc = bursa copulatrix, cxt = coxite, ga = galea, lc = lacinia, mt = mentum, papt = paraproct, plf = palpifer, prth = prostheca, ptgr = proctiger, sp = spermatheca, st = stipes. Scale bars: A = 1mm, B-E and I-K = 0.50mm, F-H = 1.00mm

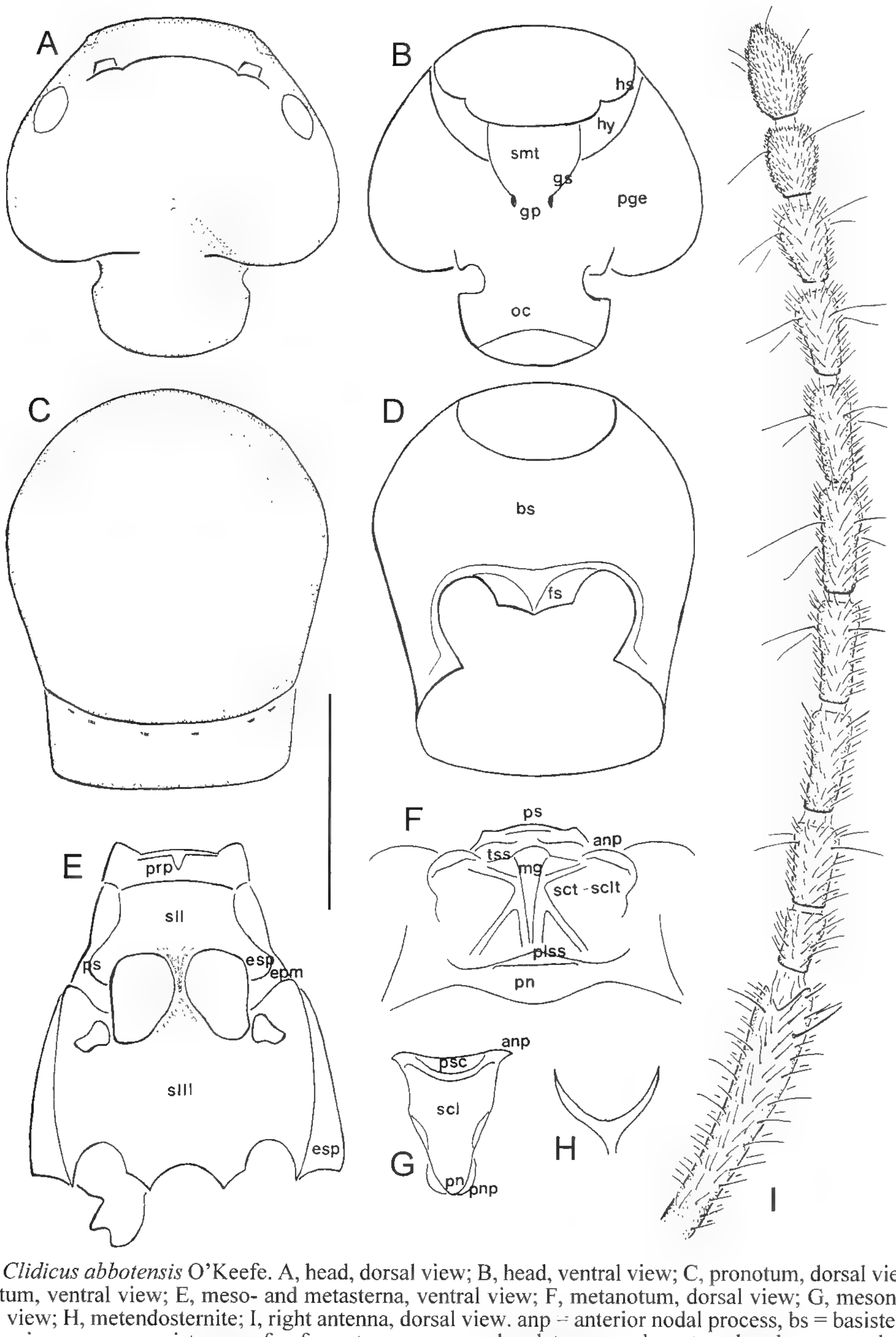

FIG. 3. *Clidicus abbotensis* O'Keefe. A, head, dorsal view; B, head, ventral view; C, pronotum, dorsal view; D, pronotum, ventral view; E, meso- and metasterna, ventral view; F, metanotum, dorsal view; G, mesonotum, dorsal view; H, metendosternite; I, right antenna, dorsal view. anp = anterior nodal process, bs = basisternum, epm = epimeron, esp = episternum, fs = furcasternum, gp = gular plate, gs = gular suture, hs = hypostomal suture, hy = hypostoma, mg = median groove, oc = occiput, pge = postgena, plss = posterolateral scutal suture, pn = postnotum, prp = prepectus, ps = prescutum, psc = prescutellum, s II = sternite II, s III = sternite III, scl = scutellum, sct-sclt = fused scutum-scutellum, smt = submentum, tss = transverse scutal suture. Scale bars: A-D and F-I = 1.00mm, E =1.50mm.

1.8mm), 1.4-1.8mm wide for males (mean = 1.6mm), 1.4-1.6mm wide for females (mean = 1.5mm); lateral margins distinctly rounded dorsoventrally as well as anteroposteriorly, widest at middle, anterior angles distinctly rounded, posterior angles tapered; posterior sixth sharply demarcated by transverse groove with 6 faint pits in a transverse row; basisternum + pre-episternum (bs) relatively long, one-third prothoracic length; tergopleural sutures lacking; furcasternum (fs) 3 × as broad as long, raised medially, anterior margin straight, posterior margin angled posteriorly at midline; procoxal cavities relatively small, widely separated by twice their length, evenly rounded.

Mesothorax. (Fig. 3E,G). Mesonotum (Fig. 3G) composed of prescutum (psc), scutellum (scl), postnotum (pn); prescutum transverse, narrow, convexly expanded posteriorly at middle, lateral margins terminate at anterior notal wing process (anp); anterior notal wing process angulate, slightly extended beyond prescutum; scutellum visible, large, twice as long as wide, subtriangular, lateral margins sharply taper posteriorly, anterior margin concave; postnotum barely visible beneath and expanded beyond scutellum, lateral margins concave, posterior margin lobed medially; posterior notal wing process (pnp) apparently reduced or absent. Mesosternum (Fig. 3E) composed of prepectus (prp), episternum (esp), epimeron (epm), basisternum (s.II); prepectus distinct, transverse, flat, marked from sternum by faint suture and narrow transverse shallow depression, fused laterally to episternum; episternum and epimeron completely separate, apex separated from body; pleural suture (ps) distinct; episternum triangular, elongate, glabrous, apex forms anterolateral border of coxal cavity; epimeron triangular, nearly as long as wide, surface glabrous, posterolateral margin with dense fringe of erect setae; basisternum broad, slightly convex before coxae, fused to episternum laterally, with sharp, raised, longitudinal carina between coxal cavities; coxal cavities broad, deep, bordered anteriorly by basisternum, anterolaterally by episternum, laterally and posteriorly by metabasisternum, medially by raised mesosternal carina, lack dense setation at posterior margin.

Metathorax. (Fig. 3E,F,H). Metanotum (Fig. 3F) composed of acrotergite, prescutum (ps), fused scutum-scutellum (sct-sclt), postnotum (pn); acrotergite narrow, transverse, forming thin, narrow, vertical wall anterior to prescutum, fused to prescutum; prescutum transverse, distinctly separated from scutum medially, anterolaterally connected to anterior notal wing process (anp), posterolaterally connected to scutum; fused scutum-scutellum large; scutellum broadly expanded anterolaterally to partially cover lateral ends of prescutum; transverse scutal suture (tss) separates anterior expansion of scutum from larger, triangular, posterior portion; postero-lateral scutal suture (plss) marks lateral margin between scutum and postnotum, medioposterior margin marked by scutoscutellar suture (sss = vr of Blackwelder, 1936); scutellum triangular, distinctly separated from postnotum; median groove (mg) distinctly bisects scutum and scutellum into right and left halves; postnotum with posterior, medially expanded, transverse portion, and expanded, lateral portions connected anteriorly to anterolateral margin of scutum. Metasternum (Fig. 3E) composed of basisternum (s.III) and episternum (eps), (epimeron not figured); basisternum large, broad, broadly longitudinally depressed between coxae, anterior margin biemarginate, form posterior and lateral margins of mesocoxal cavities, anterior margin flat, not fused to mesosternal carina, lateral margins straight, bordered by episternum, posterior margin biemarginate; coxal cavities widely separated; episternum elongate, triangular, widest at posterior end; metendosternite (Fig. 3H) composed of paired elongate-slender, parallel furcal arms attached at base directly to metasternum, lacking basal stalk, anterior arms, and postero-lateral arms.

Legs. Procoxae moderate in size, conical, contiguous; mesocoxae subequal in size to procoxae, globular, separated by small meso-sternal carina; metacoxae moderate in size, conical, distinctly, but not widely, separated; trochanters small, triangular; metatrochanter barely separates metacoxa from metafemur and bears an angulate flange in the male; femora relatively long, gradually expanded distally; tibiae elongate, slender, parallel-sided; protibia recurved, dense setal patch along distal half; mesotibia and metatibia straight; mesotibia with dense setal patch along distal half; tarsi long, slender; tarsomeres I-IV decreasing in length, tarsomere V elongate; male tarsomeres I-III with dense setal patch ventrally.

Elytra. Elytra entire, elongate, distinctly convex, 4.2-5.3mm long for males (mean = 4.8mm), 4.0-4.6mm long for females (mean = 4.3mm), 2.3-3.0mm wide for males (mean = 2.6mm), 2.3-2.6mm wide for females (mean = 2.5mm); elevated at posterior third, widest just posterior to middle; base distinctly wider than posterior of pronotum; humeri very distinct; elytral punctation in 3-5 distinct rows on each side of disc; basal fovea lacking. Hindwings fully developed. Setation long, erect, setae at apex slightly curved posteriorly.

Abdominal sternites. Sutures slightly arcuate. Visible sternite 1 twice as long as sternite 2; sternites 2-5 subequal in length; sternite 6 subtriangular, nearly as long as wide. Sternite 6 of males with distinct, broad emargination.

Male genitalia. (Fig. 2F-H). Aedeagus elongate, moderately curved dorsally, slightly narrowed distally, length 5 × width; median lobe tubular, length 3 × width, lightly sclerotised, widest at base, base rounded, slightly narrowed to apex, apex broadly truncate, open; foramen small, located 1/3 distance from base to apex of median lobe, subquadrate; base with sclerotised plate and membranous ring; parameres present, strongly sclerotised, unfused, half again longer than median lobe, each narrowed at apex with broad process pointing laterally.

Female genitalia. (Fig. 2I-K). Ovipositor composed of fused paraprocts (papt), paired valvifers (vlf), coxites (cxt), and unpaired proctiger (ptgr); styli absent; in dorsal view (Fig. 2J), paraprocts large, fused at dorsal midline only for posterior third of length, sharply taper to anterior apex, lateral margins convexly curved; proctiger subtriangular, slightly longer than wide, posterior margin densely fringed with moderate length setae; in lateral view (Fig. 2K), paraproct elongate, widest at distal third, with posterior setose cuticular expansion, narrowed ventroanteriorly; proctiger subtriangular, narrowed dorsally, widened ventrally; valvifer elongate, slender, narrowed anteriorly, unfused, but adjacent to nearly entire ventral margin of paraproct, medial margin finely corrugated; in ventral view (Fig. 2I), valvifers lightly sclerotised, elongate, slightly narrowed anteriorly, widest at base of coxites; coxites elongate, length nearly 4 × width, apex rounded, distal half densely covered with short setae. Spermatheca (sp) weakly sclerotised, oblong, expanded to cover insertion of spermathecal and accessory gland (ag) ducts; spermathecal duct long, slender, length 5-6 × length of spermatheca; accessory gland elongated with transverse apex, well sclerotised, connected to spermatheca by short duct; bursa copulatrix (bc) elongate, straight at basal half, narrowed, coiled at distal half.

LARVA. (Fig. 4A-G). Campodeiform, subparallel; entirely whitish except for reddish brown head, thoracic and abdominal terga; thorax flattened dorsally; abdomen gently narrowing, with 9 abdominal segments visible in dorsal view, urogomphi present, legs long, mandibles conspicuous. Length 8.5-8.6mm. Setation erect, sparse ventrally, dense dorsally; setae rigid, spine-shaped.

Head. (Fig. 4B-C). Prognathous and protracted, strongly depressed, with slightly differentiated neck; moderately sclerotised, testaceous, subtriangular, transverse behind, broadly rounded anteriorly, slightly wider than long; occipital foramen relatively large, without distinct raised margin forming the neck; antennal insertions dorsolateral; frontoclypeal suture absent; labrum fused to head to form nasale; gula and gular suture absent; coronal suture distinct, long; frontal sutures V-shaped, sinuate, well-defined and complete, nearly reaching the antennal insertions; ocelli present, well-defined; one single large, low dome-shaped ocellus on each side lying dorsolaterally well behind antennal insertions; dorsal head setation moderately sparse, erect; chaetetoxy as in Fig. 4B-C. Antennae (Fig. 4D) 3-segmented; antennomere I elongate, slender, length 4-5 × width, without sensilla; II elongate, cylindrical, nearly twice as long as I, two sensory appendages lying anterodorsally, elongate, spatulate; III distinct, elongate, with 3 slender terminal spines. Mandibles (Fig. 4G) typically scydmaenid, clearly divided into a broad, basal area and an apical incisor area, strongly sclerotised, with retinaculum and 1 basal tooth, with few short setae; maxillae (Fig. 4E) without visible articulating area; maxillary palpi with 3 palpomeres; palpomere I short, subcylindrical, distinctly articulated with stipes; II elongate, subcylindrical, curved; III elongate, pointed, as long as II; labium (Fig. 4F) without ligula, weakly concave apically; without a row of papilliform sensilla distally, not distinctly subdivided into prementum, mentum and submentum ventrally; labial palpi with 3 palpomeres, separated, articulated; II elongate, cylindrical; III elongate, pointed.

Thorax. Depressed, median suture distinct, terga strongly sclerotised, slightly expanded laterally, transverse; sterna membranous; mesothoracic spiracles situated anterolaterally. Legs with rows of spine-shaped setae; coxae elongate, tibia subequal in length to femora, tarsungulus with two basal setae, but lacking pre-apical barbs.

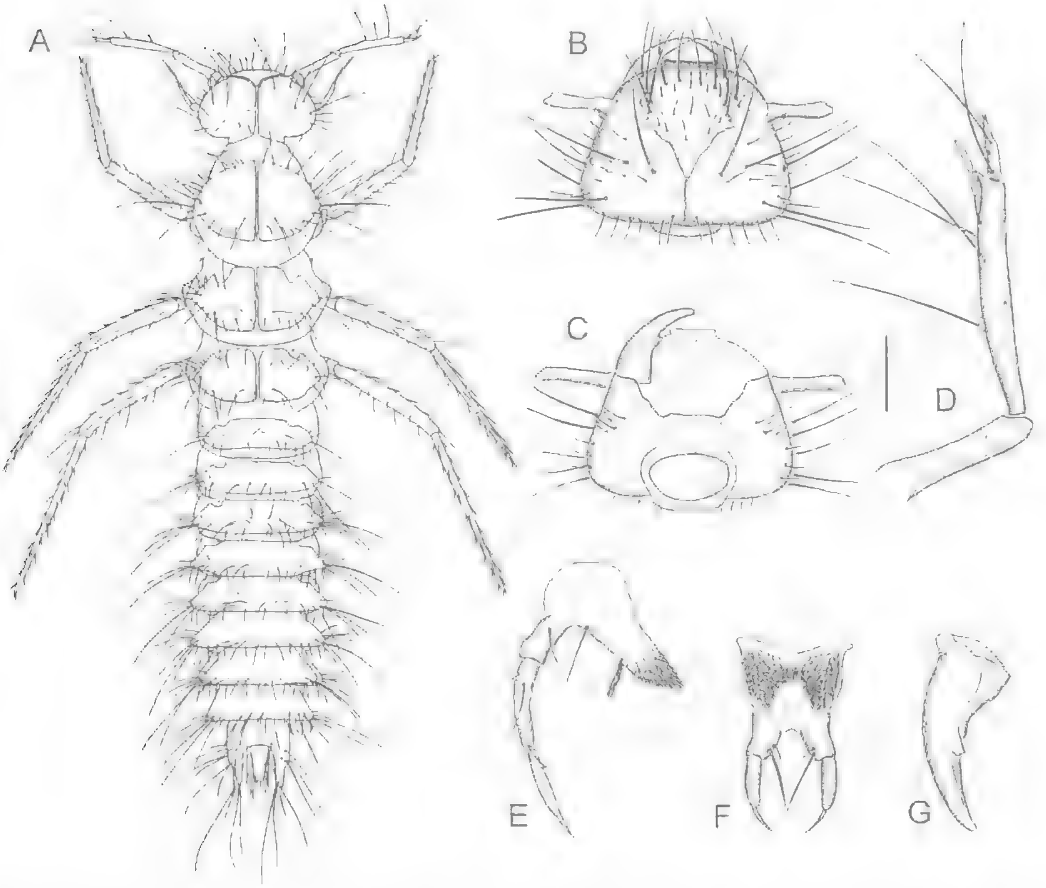

FIG. 4. Larva of *Clidicus abbotensis* O'Keefe. A, habitus, dorsal view; B, head, dorsal view; C, head, ventral view, D, right antenna, dorsal view; E, right maxilla, anterior view; F, labium, dorsal view; G, right mandible, anterior view. Scale bars: A = 1.00mm, B-C = 0.50mm, D-G = 0.25mm.

Abdominal segments. Transverse, of even width, slightly smaller than the thoracic ones, terga strongly sclerotised; setation abundant, stout, lateral setae longer, mostly originating from raised, rounded tubercles; abdominal spiracles lateral, ventroanterior to tubercle, present in segments I-VIII; segment IX transverse, trapezoidal, with a pair of pale, unsclerotised, mostly staphylinoid-like but unarticulated urogomphi, the latter pointed apically and each bearing 5 long apical setae; segment X cylindric, not visible from above because of its position on the ventral side of segment IX, the apex with a corona of short setae.

DISCUSSION

ADULT TAXONOMY. The phylogenetic relationships of *C. abbotensis* to other *Clidicus* species will be discussed when *Clidicus* is revised. Besuchet (1971) provided the most recent key to species, but it was limited to Sri Lankan species. Lhoste (1937b) provided a key to species known then, but did not revise it to incorporate *C. termitophilus* or *C. mysorensis* when he described them in 1939 (Lhoste, 1939). The key below is based on literature descriptions and discussions and is intended as a working key until there is a complete revision. Separation of *C. termitophilus* and *C. laticeps* is not possible based on their descriptions.

KEY TO ADULTS OF *CLIDICUS* LAPORTE

1. Antennomeres V-VIII distinctly longer than wide . . . 2
Antennomeres V-VIII as wide as long or nearly so . . . 6
2. Dorso-posterior impression on head round; Borneo . . . . *C. taphrocephalus* Gestro
Dorso-posterior impression on head triangular. 3
3. Elytral apices acuminate; Sri Lanka . *C. loebli* Besuchet
Elytral apices rounded 4
4. Propleura with anterior process; Sri Lanka . . . . *C. monstrosus* (Walker)
Propleura rounded anteriorly. 5
5. Antennomere I as long as II-IV combined; apices of parameres directed medially (Lhoste 1939: 508, fig. 1); India . . . . *C. mysorensis* Lhoste
Antennomere I longer than II-IV combined; apices of parameres directed laterally (Fig. 2F); Australia . . . . *C. abbotensis* O'Keefe
6. Pronotum distinctly foveate 7
Pronotum weakly or not foveate 8
7. Borneo . . . . *C. termitophilus* Lhoste
Indonesia. . . . . *C. laticeps* Pic
8. Base of pronotum with triangular depression; Sri Lanka. . . . . *C. quadricollis* Besuchet
Base of pronotum convexly rounded; Sri Lanka, Vietnam, Indonesia 9
9. 4-5mm in length 10
7-10mm in length. 11
10. Parameres shorter than median lobe which is narrowed at apex (Besuchet 1971: 256, fig. 12); Sri Lanka . . . . *C. mussardi* Besuchet
Parameres longer than median lobe which is broad at apex (Lhoste 1937a: 281, fig. 4); Vietnam . . . . *C. tonkinensis* Lhos
11. Pronotum as wide as long; antennae three-fourths body length. . . . . *C. grandis* Laporte
Pronotum wider than long; antennae subequal to body length . . . . *C. formicarius* Pascoe

CATALOGUE OF SPECIES OF *CLIDICUS*.

C. abbotensis O'Keefe, new species. AUSTRALIA (Qld)

C. balticus Schaufuss, 1896: 51; Handlirsch, 1906: 735; Larsson, 1978: 110; Spahr, 1981: 90. BALTIC AMBER.

C. formicarius Pascoe, 1863: 28, figs 2-3; Gestro, 1878: 145, 146, figs (unnumbered); Schaufuss, 1884: 394; Reitter, 1887a: 64; Reitter, 1887b: 303; Atkinson, 1891: 186; Wasmann, 1896: 16; Csiki, 1919: 86; Blattný, 1925: 1; Lhoste, 1937b: 278. BORNEO, JAVA, SUMATRA.

v. *doriae* Schaufuss, 1884: 394, 419; Reitter, 1887a: 64; Wasmann, 1896: 16; Csiki, 1919: 87. SUMATRA.

C. grandis Laporte, 1832: 397; Laporte, 1835: 130; Laporte, 1840: 209; Lacordaire, 1854: 109, pl. 16 fig. 4; Fairmaire, 1856: 529; Gestro, 1878: 145, 147, figs (unnumbered); Reitter, 1887b: 304; Atkinson, 1891: 186; Wasmann, 1896: 16; Kempers, 1899: 202, fig. 3; Csiki, 1919: 87; Lhoste, 1936: 250, fig. 1; Lhoste, 1937b: 279, fig. 3. BORNEO, JAVA.

v. *ganglbauri* Reitter, 1887a: 64; Wasmann, 1896: 17; Csiki, 1919: 87 (placed as a variety by Wasmann). JAVA.

C. laticeps Pic, 1928: 7; Lhoste, 1937b: 279. INDONESIA.

C. loebli Besuchet, 1971: 251, 254, figs 1, 6, 10. SRI LANKA.

C. monstrosus (Walker); Atkinson, 1891: 187; Csiki, 1919: 87; Lhoste, 1937b: 278; Besuchet, 1971: 251, figs 4, 8. SRI LANKA.

Erineus monstrosus Walker, 1858: 206.

C. mussardi Besuchet, 1971: 251, 255, figs 2-3, 7, 11-14. SRI LANKA.

C. mysorensis Lhoste, 1939: 508, figs 1-2. INDIA.

C. quadricolis Besuchet, 1971: 251, 252, figs 5, 9. SRI LANKA.

C. taphrocephalus Gestro, 1878: 144, figs (unnumbered); Reitter, 1887b: 303; Atkinson, 1891: 187; Wasmann, 1896: 17; Csiki, 1919: 87; Lhoste, 1937b: 278. BORNEO, SARAWAK.

C. termitophilus Lhoste, 1939: 509, figs 3-5. BORNEO.

C. tonkinensis Lhoste, 1937a: 409; Lhoste, 1937b: 279, 280, figs 1, 4. VIETNAM.

LARVA. Larvae of scydmaenid beetles are still largely unknown, none being described since Vit & De Marzo (1989). Work by Brown & Crowson (1980) is still the best general treatment of scydmaenid larvae, and Newton (1991) provided the most recent review. Detailed descriptions and figures exist only for larvae of *Stenichnus* (Wheeler & Pakaluk, 1983), *Mastigus* (De Marzo, 1983, 1984) and *Leptomastax* (Vit & De Marzo, 1989). Larvae are unknown for other species of *Clidicus*, as well as for any species in the other two genera in the tribe (*Leptochromus* Motschulsky and *Papusus* Casey).

KEY TO GENERA OF SCYDMAENIDAE BASED ON KNOWN LARVAE (modified from Vit & De Marzo, 1989).

1. Abdominal segment IX with a pair of thick urogomphi; body slender, elongate; integument pale. 2
Abdominal segment IX without urogomphi; body moderately elongate to ovate; integument more or less pigmented . . . . Cyrtoscydmini, ... Scydmaenini (see Brown & Crowson, 1980)
2. Urogomphi horny, cucujoid-like; abdominal segment X exposed in dorsal view; head with or without distinct frontal sutures and without ocelli; antennal insertions lateral; nasale without projections . . . . . . Eutheiini
Urogomphi unsclerotised, staphylinoid-like; only 9 abdominal segments visible in dorsal view; segment X situated on the ventral side of IX; head with distinct frontal sutures and large single ocellus; antennal insertions dorso-median; nasale projected in two acute lobes 3
3. Mandibles elongate, curved, without subapical teeth; thoracic and abdominal tergites not sclerotised; urogomphi apices rounded . . . *Leptomastax* Pirazzoli
Mandibles with broad base and narrowed incisor, subapical tooth present; thoracic and abdominal tergites strongly sclerotised; urogomphi apices pointed. . . . . *Clidicus* Laporte

BIOLOGY. Despite the attention *Clidicus* species have received taxonomically, very little is known about their biology. Wasmann (1896: 18) mentioned a note he had received from Fruhstorfer stating that he had found *C. formicarius* associated with the ant, *Leptogenys fruhstorferi* (Emery) in western Java. Lhoste (1939: 510) reported *C. termitophilus* was found in association with unidentified termites. Besuchet (1971: 249) noted that members of *Clidicus* were collected in leaf litter.

Field observations showed *Clidicus abbotensis* is strongly diurnal in activity and its bright orange coloring makes it quite conspicuous in daylight. After several hours headlight searching by four observers, only one specimen was found active at night in the same area where more than 100 were taken in a few hours during the day. Adults in the daytime were almost constantly on the move on the ground, on rocks and on tree bases, but were most frequently found on small and large dead logs, especially where some bark was still loosely attached. Most of those located in wet sclerophyll habitat at the summit shoulder were under loose bark sheets peeling off the base of fire-killed trees of *Allocasuarina torulosa*. To test whether their bright color and exposed activity might indicate chemical defense, a live specimen was chewed thoroughly by GBM but no distastefulness was noticed. Several mating pairs were noted in the daytime, but most of the roaming activity seemed to be involved with foraging for prey. Two adults were found carrying a soft white object in their jaws which was identified as a large, slow-moving collembolan (Neanuridae: Neanurinae: Lobellini: *Hemilobella* sp., probably undescribed; Penelope Greenslade, pers. comm.) of which many were noticed under bark and on dead wood. Seven larvae of *C. abbotensis* were collected, all walking in close proximity to foraging adults and presumably seeking the same prey. In life the larvae were the same bright color as the adults.

Tavares & Balazuc (1989) reported a new genus and species of ascomycete fungus, *Sugiyamaemyces orousettii* Tavares & Balazuc, collected from profemora and mesotibiae of two museum specimens of *C. formicarius*, one from Borneo (Zoological Museum, Berlin) and the other from Sarawak (type specimen of *C. formicarius* in the Natural History Museum, London). The senior author examined 77 specimens of *C. abbotensis* (41 males and 36 females) and found fungal thalli and conidia on 21 males, but none on any female. On all but one specimen the thalli and conidia were found only on abdominal sternites. On the remaining specimen conidia were found on abdominal sternites and on the metabasisternum immediately anterior to the left metacoxa. Dr Tavares identified the fungus as an undescribed species of *Cryptandromyces*.

DISTRIBUTION. Lhoste (1937a: 281-282) discussed the biogeography of *Clidicus* and concluded that the center of origin of *Clidicus* was Java-Sumatra-Borneo. He hypothesised that *Clidicus* had dispersed in two directions — west to Sri Lanka and north to temperate Asia. The previous distribution of *Clidicus* extended from India and Sri Lanka in the west to Indonesia (Borneo, Sumatra and Java) in the east, and Vietnam in the north (Fig. 5A). Another undescribed species occurs in the Philippines (O'Keefe, unpubl. data; specimens in Bishop Museum, Hawaii). The presence of *Clidicus* in Queensland, Australia, represents a disjunction of over 3,500km to the southeast.

It is unlikely that *Clidicus* occurs elsewhere in Australia. Given their rainforest habitat in SE Asia and the presence of this Australian species on a cool, moist mountaintop, it can be assumed that other occurrences would be in similar habitats which occur only along the coastal belt of eastern Australia. However, these mountain habitats have been intensively and systematically surveyed for insects, especially flightless ground Coleoptera, by the Queensland Museum for 20 years. *Clidicus* are conspicuous, diurnal beetles, and would not have been easily overlooked.

The isolated occurrence of *C. abbotensis* on Mt Abbot is quite remarkable, but perhaps is related to the mountain's unique geographic position. It lies as a high, cool refuge in the middle of an arid corridor formed where the 1,000mm annual rainfall isohyet swings across the coast to enclose a 200km belt of arid lowlands (Fig. 5C). This arid belt separates the mountain rainforest of the northern Cairns region (the Wet Tropics) from those of the southern Proserpine/Eungella region (Central Queensland). Darlington (1961a), on the basis of flightless Carabidae, first drew attention to this barrier and Monteith (1997), using aradid bugs, later quantified it as the most powerful barrier along the entire eastern continental margin with only 12% sharing of fauna across it.

Figure 5C shows the relationship of Mt Abbot to these rainforest systems. It is the highest massif in the 250km between Mt Williams (1,259m), an isolated peak in the Eungella systemat the southern end of the Wet Tropics, and Mt Elliot (1,220m) to the north. Another peak of

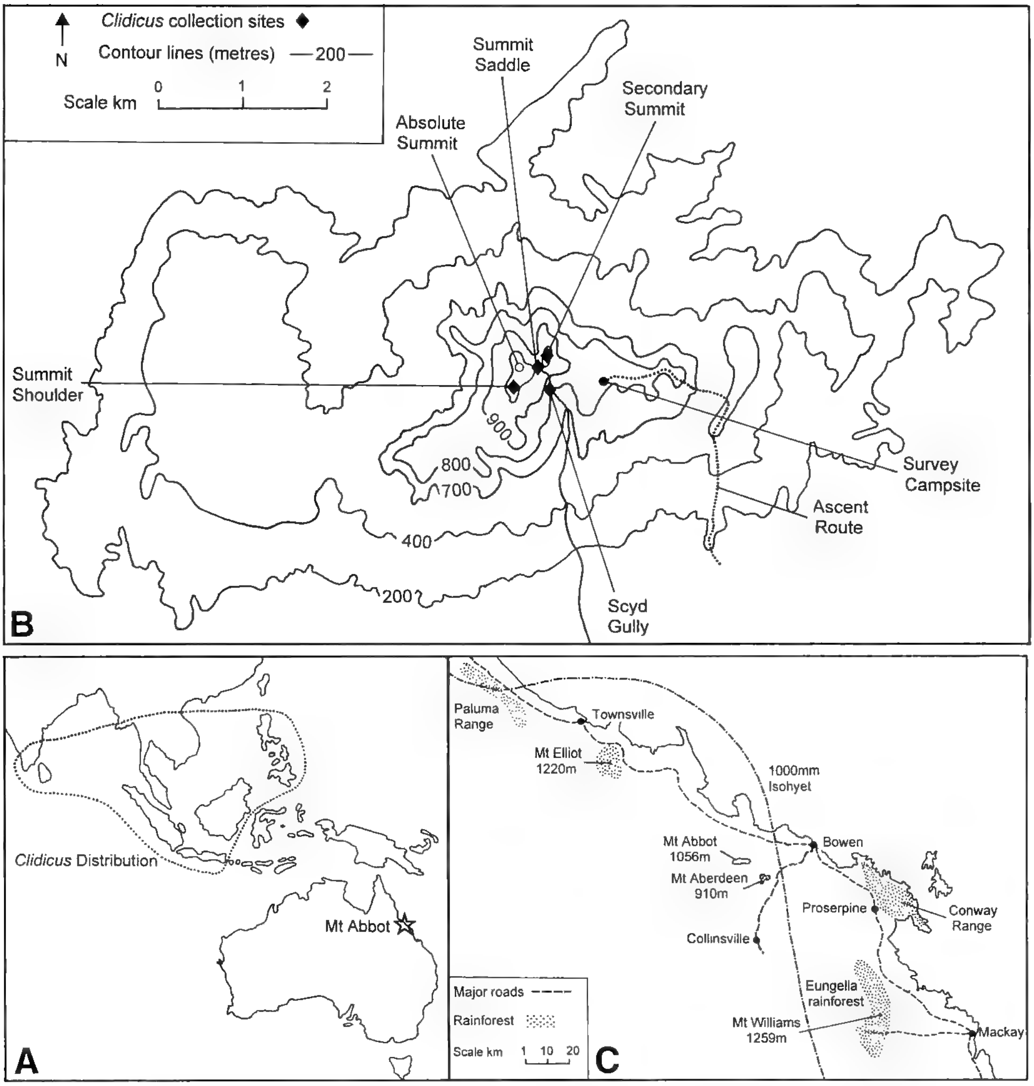

FIG. 5. A, Indo-Australian region showing previous known limits of *Clidicus* distribution and location of Mt Abbot in Australia. B, detailed topography of Mt Abbot, showing sites mentioned in text. C, location of Mt Abbot in Queensland with respect to other mountains, rainforest tracts and the 1,000mm rainfall isohyet.

significance is Mt Aberdeen (910m), about 20km SE of Mt Abbot, which is much smaller but has a small tract of cloud-induced rainforest on its narrow summit. Its insects were also sampled for the first time in 1996/97. Mt Abbot and Mt Aberdeen thus lie in an arid barrier zone where conventional wisdom has it that the flightless rainforest Carabidae which Darlington (1961a) discussed, do not occur. However, several were collected, indicating a most unusual fauna on Mt Abbot. Examples are as follows: *Pamborus* (Carabidae: Cychrini) has a species pair with *P. transitus* Darlington at Eungella and *P. tropicus* Darlington at Paluma in the Wet Tropics (Darlington, 1961b). *Pamborus* does not occur on Elliot or Aberdeen but was common on Abbot where the species is the southern *P. transitus*. *Mystropomus* (Carabidae: Ozaenini) has a species pair with *M. subcostatus* Chaudoir at Eungella and *M. regularis* Banniger at Paluma.

Again, no *Mystropomus* occurs on Elliot or Aberdeen but in this case the northern species, *M. regularis*, was common on Abbot. *Apocryphodes* (Tenebrionidae: Adeliini) is a newly described genus thought restricted to the Wet Tropics zone (Matthews,1998). It was not found at Elliot or Aberdeen but a new species was collected on Abbot. *Canthonosoma* (Scarabaeidae: Scarabaeini) is a genus of flightless dung beetles with three species thought restricted to the south of Rockhampton (Matthews, 1974). Members of the genus were found 300km further north on the summits of both Mt Aberdeen and Mt Abbot. But whereas the Aberdeen species was the common Rockhampton species, *C. macleayi* Harold, the population on top of Abbott, only 20km distant, is a striking new endemic species with prominent elytral costae.

This highly disharmonic fauna on the summit of Mt Abbot, with elements from both sides of a major biogeographic barrier preserved side by side, indicates an ancient refugial capacity which has absorbed these elements from periods in the distant past when climatic and physiographic fluctuations perturbed the barriers which are in place today. The presence of *Clidicus* there indicates that these factors have perhaps acted at an even greater distance scale in the past than applies to the examples above.

ACKNOWLEDGEMENTS

We thank Geoff Thompson for preparing Figures 1, 2A, 4A and 5, Eric Conti for assistance with translations from French and Italian, Isabelle Tavares for identification of the fungus, Don Chandler, Jerry Cook and Alfred Newton for comments improving this paper, and Doug Cook, Chris Burwell and Heather Janetzki for assistance in collection of specimens.

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A NEW SPECIES OF FUNNEL-WEB SPIDER (*HADRONYCHE*: HEXATHELIDAE: MYGALOMORPHAE) FROM NORTH QUEENSLAND

ROBERT J. RAVEN

Raven, R.J. 2000 12 31: A new species of funnel-web spider (*Hadronyche*: Hexathelidae: Mygalomorphae) from north Queensland. *Memoirs of the Queensland Museum* **46**(1): 225-230. Brisbane. ISSN 0079-8835.

Hadronyche anzses sp. nov. is described from high altitude rainforest on the Carbine Tableland near Mossman, northeast Queensland. This extends the known range of funnel-web spiders northwards by 1,050km. ❐ *Mygalomorphae, Hexathelidae, Hadronyche, envenomation, phenology, biodiversity, biogeography, Australia.*

Robert J. Raven, Queensland Museum, PO Box 3300, South Brisbane 4101, Australia; (email: RobertR@qm.qld.gov.au); 21 July 1999.

The highly venomous funnel-web spiders of Australia belong to *Atrax* O.P. Cambridge, 1877 and *Hadronyche* Koch, 1873, included by Gray (1986, unpubl.) in the subfamily Atracinae within the Hexathelidae. The group occurs in coastal and montane forests through southeastern Australia. Popular misconception has been that many large, black, ground-dwelling spiders to the west of the Great Dividing Range were funnel-webs. Thus the discovery of a new species of funnel-web in north Queensland may not seem exciting. The misconception presumably began with the description of a funnel-web, *Anepsiada ventricosa* Rainbow & Pulleine, 1918, putatively from Clermont, central Queensland. However research on Rainbow's original notes (Gray, 1981, 1984) revealed that a transcription error has resulted in the funnel-web, actually from Mt Tamborine, in southeastern Queensland, being attributed the Clermont locality data. More intensive collecting over the past 70-80 years has shown quite conclusively that neither *Atrax* nor a close relative are native to western Queensland. Indeed, spiders often mistaken for funnel-webs in this area are presumably either *Aname* (Nemesiidae), *Idiommata* (Barychelidae) or *Missulena* (Actinopodidae), all being black spiders, quick to take on a defensive (=aggressive) pose.

Previously, the most northerly known record of either *Hadronyche* or a close relative was west of Gladstone at Kroombit Tops (Gray, 1984, 1986, 1987, 1988; Queensland Museum records). The distribution of the Atracinae – coastal and montane areas south of Gladstone to Victoria and eastern Tasmania and in two southern areas of South Australia – agreed with that of other Australian Hexathelidae (Raven, 1978). As such, the hypothesis that the group has austral origins seemed secure. Nevertheless, this record of a new species from relatively inaccessible, mountain rainforests over one day's march through rugged terrain west of Mossman (1,000km north of Gladstone), in the Wet Tropics of northern Queensland is authentic and may challenge such a notion.

Family HEXATHELIDAE Simon

Hadronyche L. Koch, 1873

Hadronyche L. Koch, 1873: 463. Type species by original designation and monotypy, *Hadronyche cerberea* Koch, 1873.

DIAGNOSIS (from Raven, 1980). Three claws; numerous cuspules densely clustered on labium and maxillae; serrula present; labium large, almost square; posterior sternal sigilla large; 4 spinnerets, posterior laterals with digitiform apical segment. Plesiomorphically, with a row of teeth on both cheliceral margins. Patella and tibia of male palp enlarged.

REMARKS. A further unusual character is added to the diagnosis. In most male mygalomorphs, the diameter of the palpal patella is less than that of the femur. In *Hadronyche*, the patella is noticeably thicker than the femur and this greater diameter is maintained in the tibia. In other hexathelids, the palpal patella is as large as the femur or smaller. The enlarged patella and tibia are hence regarded as a further synapomorphy of *Hadronyche* species.

DISTRIBUTION AND HABITAT. *Hadronyche* is found through forests along the coast south of 24° (Fig. 4) with one outlier west of Mossman at 16°. Most such forests are found above 500m in altitude.

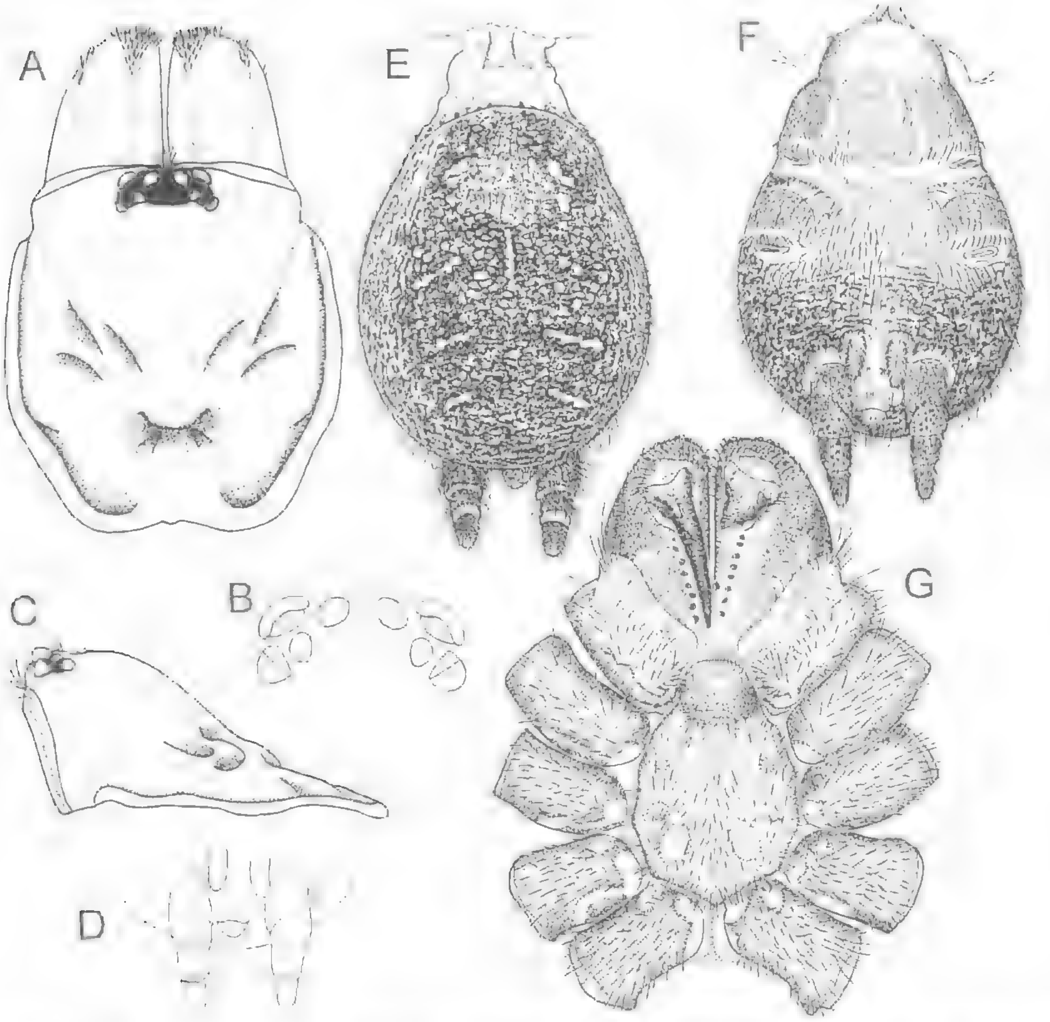

FIG. 1. *Hadronyche anzses* sp. nov., holotype ♂. A, carapace, eyes, chelicerae, dorsal view; B, eyes, dorsal view; C, carapace, lateral view; D, spinnerets, ventral view; E, abdomen and spinnerets, dorsal view; F, abdomen and spinnerets, ventral view; G, sternum, maxillae, labium, chelicerae (showing fang groove), and coxae. Scale line = 2mm for A, C-F, 1mm for B, G.

Hadronyche anzses sp. nov.
(Figs 1-4)

ETYMOLOGY. From the acronym for the Australian New Zealand Scientific Exploration Society which assisted the fieldwork.

MATERIAL. HOLOTYPE: QMS18825, ♂, Mossman Bluff summit, 10km W Mossman, 16°26'54"S 145°16'53"E, NEQ, 20 Dec 1989-15 Jan 1990, G Monteith, G Thompson, and ANZSES Expedition, Site 10, 1300m, pitfall, rainforest. PARATYPES: QMS18826, ♂, same data but site 9, 1260m, 16°27'23"S 145°16'59"; QMS18859, ♂, Devils Thumb to Pauls Luck, 12km WNW Mossman, 16°25'09"S 145°15'29"E, NEQ, 29 Dec 1989-15 Jan 1990, ANZSES Expedition, site 15, 1220m, pitfall trap, rainforest.

DIAGNOSIS. Differs from all other named species of *Hadronyche* in having teeth for full length of retromargin but only three teeth on the usually heavily dentate promargin; males with less spinose tibiae and metatarsi I, and lacking spines on distal palpal femora. Females unknown.

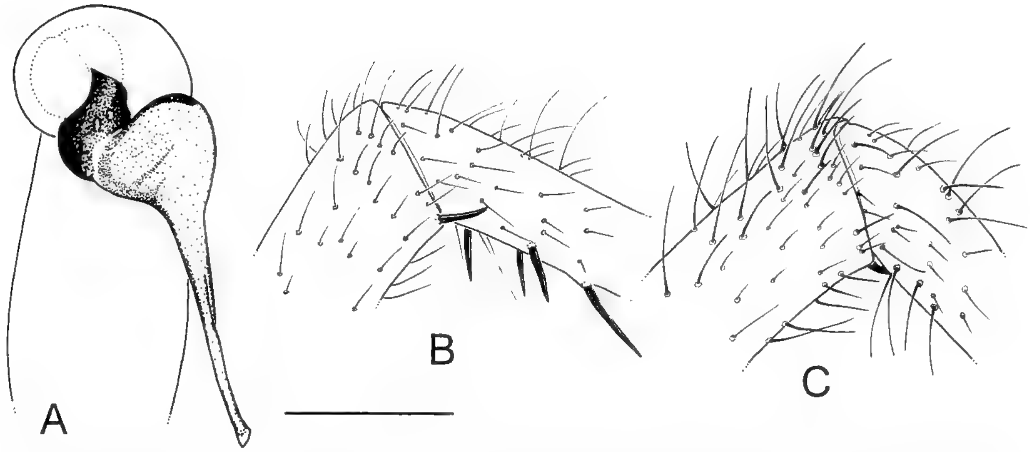

FIG. 2. *Hadronyche anzses* sp. nov., holotype ♂. A, palpal tibia, cymbium, and bulb, ventral view; B, tibia and metatarsus I, prolateral view; C, tibia and metatarsus II, prolateral view. Scale line = 1mm.

DESCRIPTION. Holotype ♂ QMS18825. Carapace 5.31mm long, 5.13 wide. Abdomen 5.63 long, 4.50 wide. Total length, 15.

Colour in Alcohol. Carapace and chelicerae dark red-brown, legs brown with three wide green-brown bands on prolateral and dorsal femora. Abdomen (Fig. 1E) dorsally brown with many fine pallid areas uniformly, a few enlarged areas anteriorly and two pairs of fine diagonal pallid lines in posterior half; laterally brown, ventrally pallid in centre and anteriorly, mottled brown near spinnerets; sternum, maxillae and labium orange-brown; leg coxae concolorous with legs; fangs dark red-brown.

Carapace. Pilosity: with few short fine brown hairs along margins; numerous small pallid pits indicate possible origins of hairs; anterior and second striae deep distinct, others shallow, wide; 8-10 small setal bases anteromedially; 4 long thin bristles and few finer between PME, and 3-4 long thin between ALE; one large setal base scar between AME; few fine hairs on lateral margins. Fovea broad, deeply procurved to U-shaped; no foveal bristles. Caput short, strongly arched (Fig. 1C). Edges of carapace upturned to form distinct ridge and trough, most distinct posteriorly. Clypeus absent.

Eyes (Fig. 1B). Tubercle low, gradually defined. Group occupies 0.32 of head-width. Back row recurved; front row straight. Group front width, back width, length, 52:55:23. MOQ front width, back width, length, 28:37:19. AME:ALE:PME:PLE, 12:14:7:10. AME-AME, 0.4, AME-ALE, 0.1, PME-PLE, 0.3, PME-PME, 2.1, ALE-PLE 0.4.

Chelicerae. Large, strong, rounded, few short fine brown prostrate bristles prodorsally and in two lateral bands; anterior curve of chelicerae with many short strong bristles becoming weaker over fang edge. Rastellum absent. Fang smooth but for midbasal triangular tooth. Furrow promargin with 3 separated basal teeth, otherwise promargin smooth, glabrous; retromargin with 1 small and 8 large strong teeth, basomesally with 3 small teeth. Intercheliceral tumescence absent.

Labium. 1.30mm wide, 0.79 long (Fig. 1G). Labiosternal suture a wide continuous groove. With ca. 100 fine pointed cuspules on anterior edge.

Maxillae. 2.18mm long in front, 2.06 long behind, 1.21 wide; with ca. 70 fine pointed cuspules in triangle extending for three-quarters of length. Heel rounded, unmodified; anterior lobe large conical, lower surface convex, forming broad incrassate region subapically. Serrula broad, distinct, extending from anterior face of lobe to just behind it.

Sternum. 3.24mm long, 2.67 wide (Fig. 1G). Sigilla position, size, shape, and distance from margin: posterior, 0.67, oval, 0.36; middle, 0.33, oval, 0.33; anterior, 0.21, tear-shaped, 0.21. Sternal margin with fine hairs, rest with long fine bristles.

Legs. Legs I, II without apparent modifications (Fig. 2B,C). Tarsi III, IV noticeably ballooned or incrassate for their length; scopulate areas pallid. See Table 1 for measurements.

Scopula. Short erect hair (not obscuring cuticle) on ventral surface of tarsi II (thin), III, IV, small area of scopulate hairs distal on metatarsi IV;

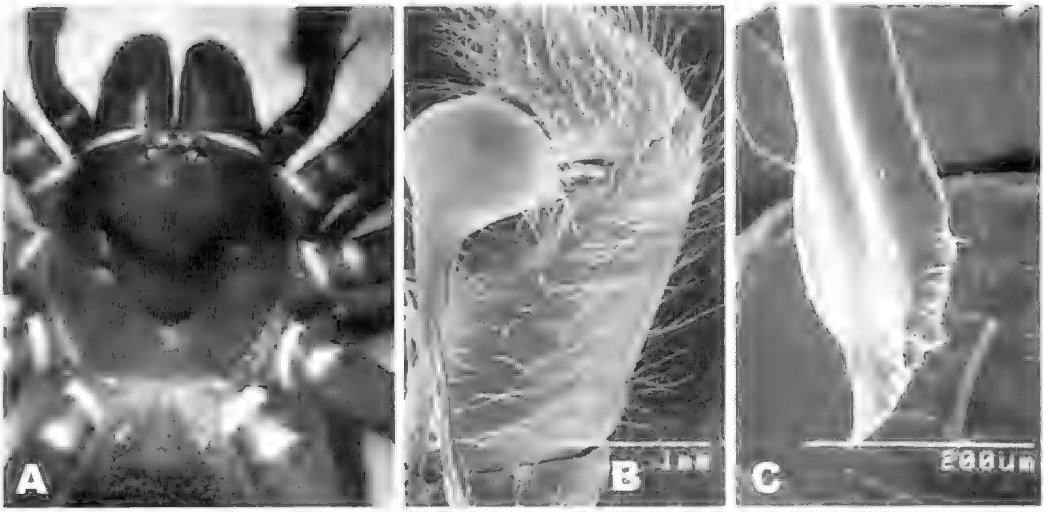

FIG. 3. *Hadronyche anzses* sp. nov., ♂. A, carapace, eyes, chelicerae; B, palpal tibia, cymbium, and bulb, proventral view; C, embolus, proventral view.

absent elsewhere. No preening combs or modified spines evident on legs.

Spines. All femora aspinose. Leg 1, pa 0, ti v4, me v10, ta v4; leg 2, pa 0, ti v4, me v7, ta v6; leg 3, pa p12, ti p3, v3, me p2, r1, v7, ta p1, r1, v8; leg 4, pa p3-7 thornlike, ti p0-1, v3, me v3, ta p1, v2+4; palp, 0.

Claws. Leg I: 7 teeth increasing gradually in length from the base to third tooth then gradually decreasing and crossing to inner face of claw distally on paired claws, 2 small thin teeth on unpaired claw; leg IV similar but unpaired claw bare.

Trichobothria. In two rows, each of 4 for just over half of tibiae, rows are straight and lack prolateral curve of small trichobothria proximally; ca. 7 on metatarsi for distal two-thirds in slightly irregular line; ca. 6 filiform on tarsi in irregular line. Tarsal organ small, distal, distinctly raised.

Palp (Figs 2A, 3B,C). Patella and tibia incrassate; femora dark red brown. Bulb small, pyriform; embolus long, tapering gradually to flared tip, keel begins one-sixth of length from origin; tip grooved for distal one-sixth; cymbium short, aspinose.

TABLE 1. Leg measurements (mm) of *Hadronyche anzses* sp. nov., holotype ♂.

	I	II	III	IV	Palp
Femur	4.19	3.88	3.63	4.25	2.88
Patella	2.25	2.25	2.06	2.31	1.69
Tibia	2.69	2.38	2.06	2.81	2.25
Metatarsus	2.75	2.50	2.50	3.31	
Tarsus	1.56	1.56	1.69	2.13	1.19
Total	13.44	12.57	11.94	14.81	8.01

Abdomen (Fig. 1E, F). Posterior booklungs large, slits as wide as those of anterior pair; covers yellow brown, hirsute.

Spinnerets (Fig. 1D). PMS 0.82mm long, 0.30 wide, 0.36 apart, about 0.46 of basal PLS in diameter; spigots on pallid area ventrally in distal third. PLS length of basal, middle, apical, and total articles 1.73, 0.45, 0.61, 2.79, respectively; spigots ventrally in pallid area in distal third of basal article, and full length of others.

RELATIONSHIPS. The generic affinities of this new species generate a profound dilemna. The species has many autapomorphies making it distinct from both *Atrax* and *Hadronyche*. However, the elevation of this species to genus would leave both *Atrax* and *Hadronyche* defined only by plesiomorphic characters and is hence cladistically indefensible. Equally, however, the continued separation of *Atrax* and *Hadronyche* lacks any support.

Hadronyche anzses presents a unique combination of characters in the genus in which it most closely resembles Gray's (1987) *Hadronyche* 'species 19'. Those characters are the reduced length and dentition of the row of teeth on the cheliceral promargin and the short almost dome-shaped apical segment of the posterior

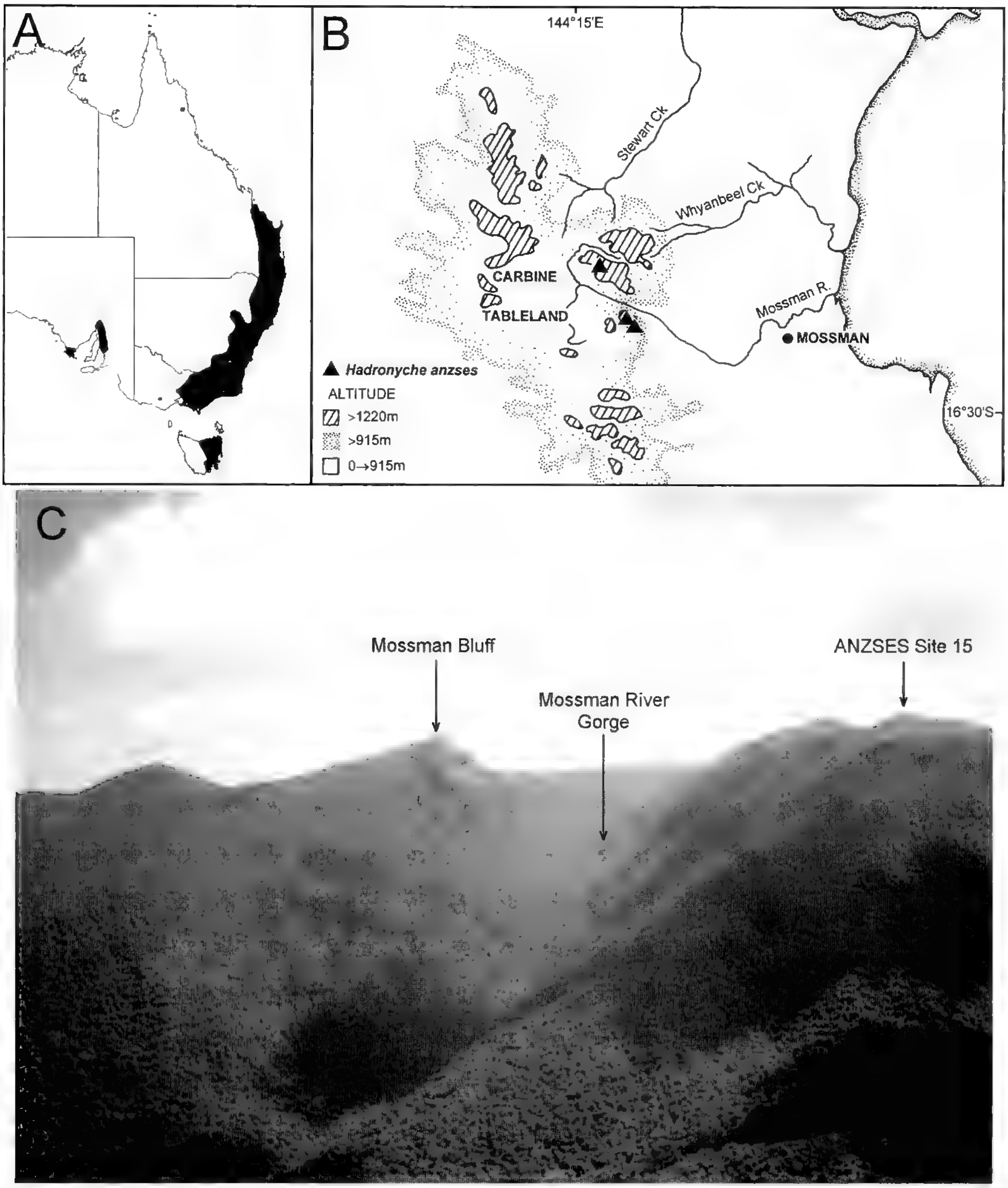

FIG. 4. A, occurrence of *Hadronyche* in Australia; B, *Hadronyche anzses* sp. nov. records. C, aerial view from the east towards the ranges west of Mossman, showing the two collection localities for *Hadronyche anzses*, separated by the deep Mossman River Gorge. (Photograph by Juliana Russell)

lateral spinnerets. Because all mygalomorphs have the promarginal row (Raven, 1985), the reduction is most parsimoniously considered an autapomorphy of the species pair. Like most species included by Gray (1987) in *Hadronyche*, the caput of *Hadronyche anzses* is arched. The short spinnerets are also, by outgroup comparison, apomorphic. Hence, *Hadronyche anzses* plus 'species 19' are well defined but the balance of the taxa await Gray's revision for a synapomorphy.

DISTRIBUTION AND HABITAT. *Hadronyche anzses* is known from two adjacent mountain massifs on the coastal rim of the extensive Carbine Tableland which lies immediately to the west of Mossman (Fig. 4). The two sites are only 5km apart but are separated by the deep gorge of the Mossman River which plunges almost to sealevel. Both sites reach the highest altitudes on the whole Tableland and, although rainfall records are not available, it would be expected that their high, easterly exposure would attract rainfall maxima for the Tableland also. The habitat at both sites is high-altitude rainforest classified by Tracey & Webb (1975) as simple microphyll vine-fern thicket. This vegetation type is very limited in extent in the Wet Tropics, being restricted to wet, cloud-prone, windswept topslopes of granitic highlands. The failure to collect this spider during extensive pitfall trapping by the Queensland Museum at more accessible, though lower and drier, parts of the Carbine Tableland (Mt Lewis road, Mt Spurgeon area), indicates that it is probably restricted to the high, wet, eastern rim.

The Carbine Tableland is known to be one of the major centres of invertebrate diversity and endemicity in the Wet Tropics region (Monteith, 1995) and the discovery of this interesting, disjunct spider accords with this pattern.

ACKNOWLEDGEMENTS

I am grateful to an Australian Research Council grant that facilitated this study. Figures were drawn by Clare Bremner except Fig. 4b which is by Geoff Thompson. I am grateful to M.R. Gray, Australian Museum, Sydney, M.S. Harvey, Western Australian Museum, Perth, and Jeanette Covacevich and G. Monteith, QM, for useful comments and additions to the manuscript.

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A COMPLEX OF CRYPTIC SPECIES IN THE GENUS *COPTODACTYLA* BURMEISTER (COLEOPTERA: SCARABAEIDAE: COPRINI)

C.A.M. REID

Reid, C.A.M. 2000 12 31: A complex of cryptic species in the genus *Coptodactyla* Burmeister (Coleoptera: Scarabaeidae: Coprini). *Memoirs of the Queensland Museum* **46**(1): 231-251. Brisbane. ISSN 0079-8835.

The *subaenea* species-complex in the coprine genus *Coptodactyla* Burmeister is described, comprising *C. nitida* Paulian, *C. papua* Lansberge, *C. subaenea* Harold and three new species, *C. matthewsi* and *C. storeyi*, from North Queensland, and *C. merdeka* from New Guinea. *Coptodactyla nitida* Paulian is removed from synonymy with *C. subaenea*. These externally almost identical species are primarily discriminated using sexual characters, namely the parameres, endophallus and vulvar sclerites. A phylogenetic analysis of the species complex is given. Five of the species are allopatric with respect to each other. Two sister species are widespread but allopatric in the Wet Tropics of North Queensland, where they meet at the Black Mountain Barrier, a known dry climate barrier at past periods of maximum aridity. A key is given for the 17 species of *Coptodactyla* and lectotypes are designated for *C. papua* and *C. subaenea*. ❐ *Coleoptera, Scarabaeidae, Coptodactyla, Australia, New Guinea, taxonomy, biogeography.*

Christopher Athol McEwan Reid, Co-operative Research Centre for Tropical Rainforest Ecology & Management, James Cook University, Smithfield 4878, Australia (current address: Centre for Biodiversity and Conservation Research, Australian Museum, 6 College Street, Sydney 2000, Australia); received 31 March 2000.

This paper revises a species-complex in the dung-beetle genus *Coptodactyla* Burmeister, which is abundant in the closed forests of north Queensland. The project is one of several initiated by the Co-operative Research Centre for Tropical Rainforest Ecology and Management, Cairns, which aim to provide a sound taxonomic and phylogenetic framework for the more significant genera of the Queensland Wet Tropics World Heritage Area. This survey of scarabaeine distribution and systematics has led to studies of diversity (Monteith, 1995) and area relationships within the Wet Tropics (Reid, Cranston & Reid, in press).

Such a project is feasible primarily thanks to the sound taxonomic base provided by Eric Matthews 27 ago (1972, 1974, 1976) and the subsequent efforts of project collaborators Geoff Monteith (Queensland Museum, Brisbane), Ross Storey (Department of Primary Industries, Mareeba) and Tom Weir (Australian National Insect Collection, Canberra), who have collected, curated and sorted 40,000 specimens of about 190 species (G. Monteith, pers. comm.) of Wet Tropics scarabaeines. Their collective resource provides an excellent platform for revisionary taxonomic studies.

Coptodactyla Burmeister is a genus of coprine scarabs (Montreuil, 1998) confined to Australia and New Guinea. The Australian species were comprehensively revised by Matthews, using male characters (Matthews, 1976). He had much less material available than the present author and did not examine the female genitalia or the male endophallus; examination of these structures has allowed more detailed discrimination of species and populations. This study has revealed six sibling species confused under the names *C. papua* Lansberge, *C. subaenea* Harold and C. *nitida* Paulian. No other taxonomic changes are necessary in the genus.

MATERIALS AND METHODS

Male genitalia were immersed in dilute KOH for several hours, then transferred to water. The parameres were removed from the basal piece, and the penis and endophallus extracted. The penis was separated from the endophallus by cutting the thin connecting membrane at the apex of the penis. The endophallic lobes were everted with fine forceps. The ejaculatory sac was not inverted as the sclerites were more clearly visible in the relaxed condition.

Female genitalia, including the vulvar sclerites, were removed from the apical abdominal ventrite, softened in dilute KOH, then water, and cleaned. The spermatheca was examined in glycerol.

Terminology largely follows Mathews (1976), with the following additions. Scarabaeines

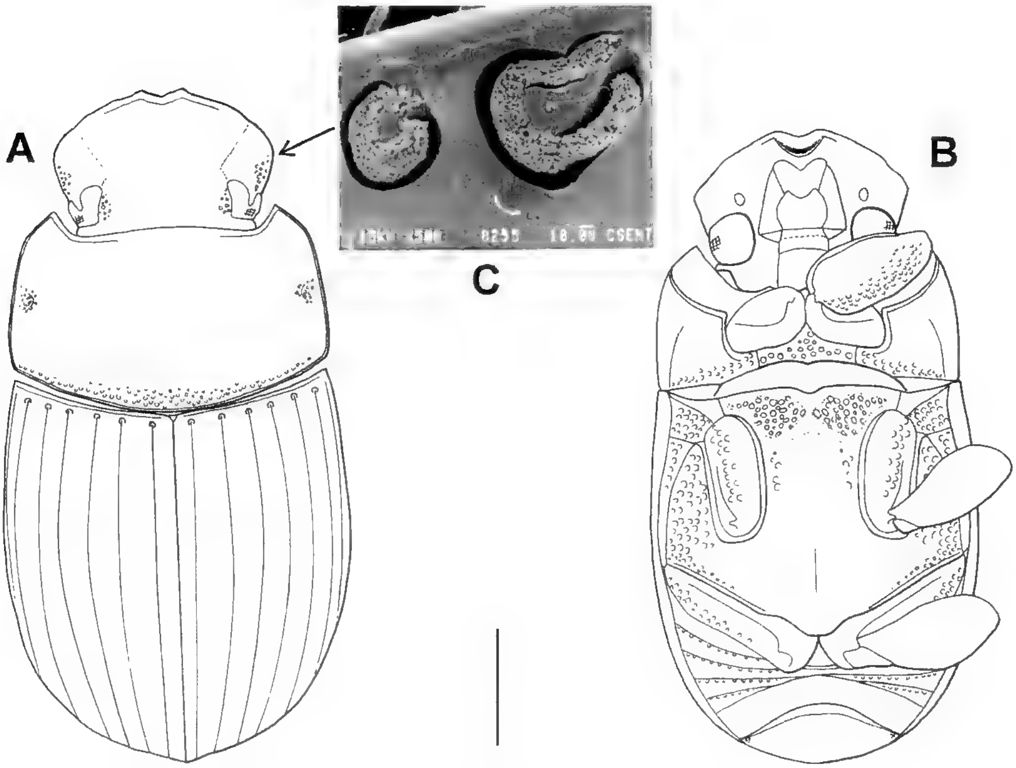

FIG. 1. *Coptodactyla subaenea* Harold, ♂, showing distribution of annular punctures. A, dorsum; B, venter; C, detail of annular punctures anterior to eye. Scale bar = 2mm.

commonly have patches of large annular punctures (Krikken, 1977) and the distribution of these is important for discriminating species in *Coptodactyla*. These punctures are deep (Fig. 1C), enclose setae, and may function as fungal storage pits for inoculating larval food. A nomenclature of male endophallic sclerites in Coprini is provided by Génier (1996), but this appears to be inappropriate for *Coptodactyla* species. The endophallus of all Australian species of the coprine genera *Coptodactyla* and *Thyregis* Blackburn has been examined. There are always three basal sclerites (Fig. 5B), in an ejaculatory sac, which form the sperm pump when everted: the flagellum, relatively short and stout and without divergent apices (flagella of Génier); the basal sclerite, a folded plate adjacent to the apical half of the flagellum; the ring sclerite, at or beyond the tip of the flagellum. Other areas of sclerotisation may be present (as in Fig. 5B), but when observed through the inverted wall are poorly defined and generally only lightly sclerotised. In *Coptodactyla* there is always a lateral sac (Fig. 5B), which may be further subdivided, branching off the base of the ejaculatory sac.

The female genitalia of *Coptodactyla* are unusual amongst Scarabaeinae in having extensive secondary sclerotisation around the vulva. The area immediately around the vulva is the vulvar sclerite (Fig. 9B), which may be lobed and asymmetrically folded. Between the vulvar sclerite and the anus there is usually a strongly sclerotised transverse bar, the dorsal sclerite, which may be derived from fusion of the hemisternites.

Seventeen hundred and fifty specimens of the *subaenea*-species complex were examined. Abbreviations for depositories are as follows: ANIC, Australian National Insect Collection, Canberra; BMNH, Natural History Museum, London; CMN, Canadian Museum for Nature, Ottawa; MCG, Museo Civici, Genoa; MZB, Museum Zoologicum Bogoriense, Bogor, Indonesia; DPIM, Queensland Department of Primary Industry, Mareeba; QM, Queensland Museum, Brisbane. The latitude and longitude for

Australian localities included in this revision are available from the Collection Manager, ANIC.

Abbreviations for collectors' names with more than one entry are as follows: GB, G. Bornemissza; EB, E.B. Britton; JGB, J.G. Brooks;DC, D.J. Cook; JF, J. Feehan; PF, P. Ferrar; HAH, H. & A. Howden; SM, S. Misko; GM, G. Monteith; GSM, G. & S. Monteith; CR, C.A.M. Reid; RS, R.I. Storey; GT, G.I. Thompson; AWH, A. Walford-Huggins; TW, T.A. Weir; DY, D. Yeates; PZ, P. Zborowski. Other abbreviations: Bch, Beach; C, Cape; Ck, Creek; I., Island; Mt, Mount/Mountain; NP, National Park; Pt, Point; Ra., Range; R., River; Rd, Road; Tbld, Tableland.

Descriptions are based on freshly emerged specimens, if available. Older specimens may have densely scratched and dull dorsal surfaces, and the oldest individuals have their protibiae reduced to pointed stumps and frontoclypeal anterior margins eroded.

Coptodactyla Burmeister, 1846

TYPE SPECIES. *Copris glabricollis* Hope, 1842, by monotypy (Matthews 1976).

DISTRIBUTION. Australia (coastal Queensland and Northern Territory) and New Guinea.

REMARKS. The genus was comprehensively described and its synonymy was discussed by Matthews (1976). The new species added below do not require any alteration to this description. Hitherto two species of this genus have been distinguished by the incomplete border (beading sensu Matthews) of the anterior edge of the pronotum. Here four additional species with this character-state are described and the whole group is placed in the *subaenea* species-complex.

Coptodactyla subaenea species-complex

DIAGNOSIS. Anterior border of pronotum medially effaced (Figs 1A, 2A-B); striae 8 and 9 complete to elytral base; males without secondary sexual modifications of head, pronotum or legs (Fig. 1); apices of parameres strongly deflexed (Fig. 2C-F); endophallus with one lateral sac (Fig. 5B).

DESCRIPTION. The following attributes are shared by all species of this complex and will not be repeated in the species descriptions (but note that some features may be obliterated or obscured in worn specimens).

Length 8-13.5mm, but rarely <9.5mm. Annular punctures, either circular or semicircular, distributed as follows (Fig. 1): sides of frontoclypeus anterior to eyes; inner margin of eyes; lateral pronotal pit; posterior margin of pronotum; posterior of prosternum; posterior of hypomeron internal to lateral groove; base of each stria; mesosternum; mesepimeron; sides and anterior of metasternum; metepisternum; hind margin of profemur; meso- and metacoxae; row across base of each ventrite except last; lateral angles of pygidium.

Head (Figs 1, 2A-B). Dorsum without ridges or horns in either sex; fronto-clypeal margin with slight notch at junction of gena, produced anteriorly as two upturned triangular lobes with median notch; downturned apex of clypeus almost triangular, with marginal arcuate groove for most of width (Fig. 1B); lateral (genal) angles blunt, sides contracted in straight line towards eyes; eye divided by narrow canthus for half of lateral length; eyes separated by 4-6 dorsal eye widths; most of anterior of frontoclypeus transversely rugose (wrinkled), head between eyes variably punctured, convex; antenna: length segment 1 at least equal to 2-6 combined, 2 elongate globular, 3 triangular, 3-6 increasing in width, 4-6 decreasing in length, width 6 twice length, 7-9 forming lamellate club, 7 shallowly excavate at base to house 6, 7-9 decreasing in width; last segment of maxillary palp fusiform, length 2-2.5x penultimate segment.

Thorax (Figs 1, 2A-B). Pronotum: anterior evenly convex, without excavation or tubercles, base with faint median longitudinal impression; sides of pronotum almost straight to shallowly curved; upper surface almost entirely punctured, more strongly at sides; anterior edge without border for middle eighth to third; two circular lateral median depressions present, connected to anterior angles by shallowly convex and often effaced ridge; hypomeron with long submarginal ridge c.0.75 length from base towards anterior excavation, impunctate except annular punctures; scutellum minute, size equal to pronotal sensory pit; elytra with 9 distinct deeply grooved, but feebly punctured (slightly foveolate), striae complete to base, stria 10 along edge of epipleuron, stria 9 fused to 10 one third from base; interstices flat except apical half of suture slightly convex and outer edge of elytron convex between striae 8 and 9, but without pseudepipleuron; meso- and metasterna completely fused; middle of metasternum shining, finely and sparsely punctured; wings fully developed; mid and hind trochanters with small tuft of dense stiff golden setae (may be abraded); male without

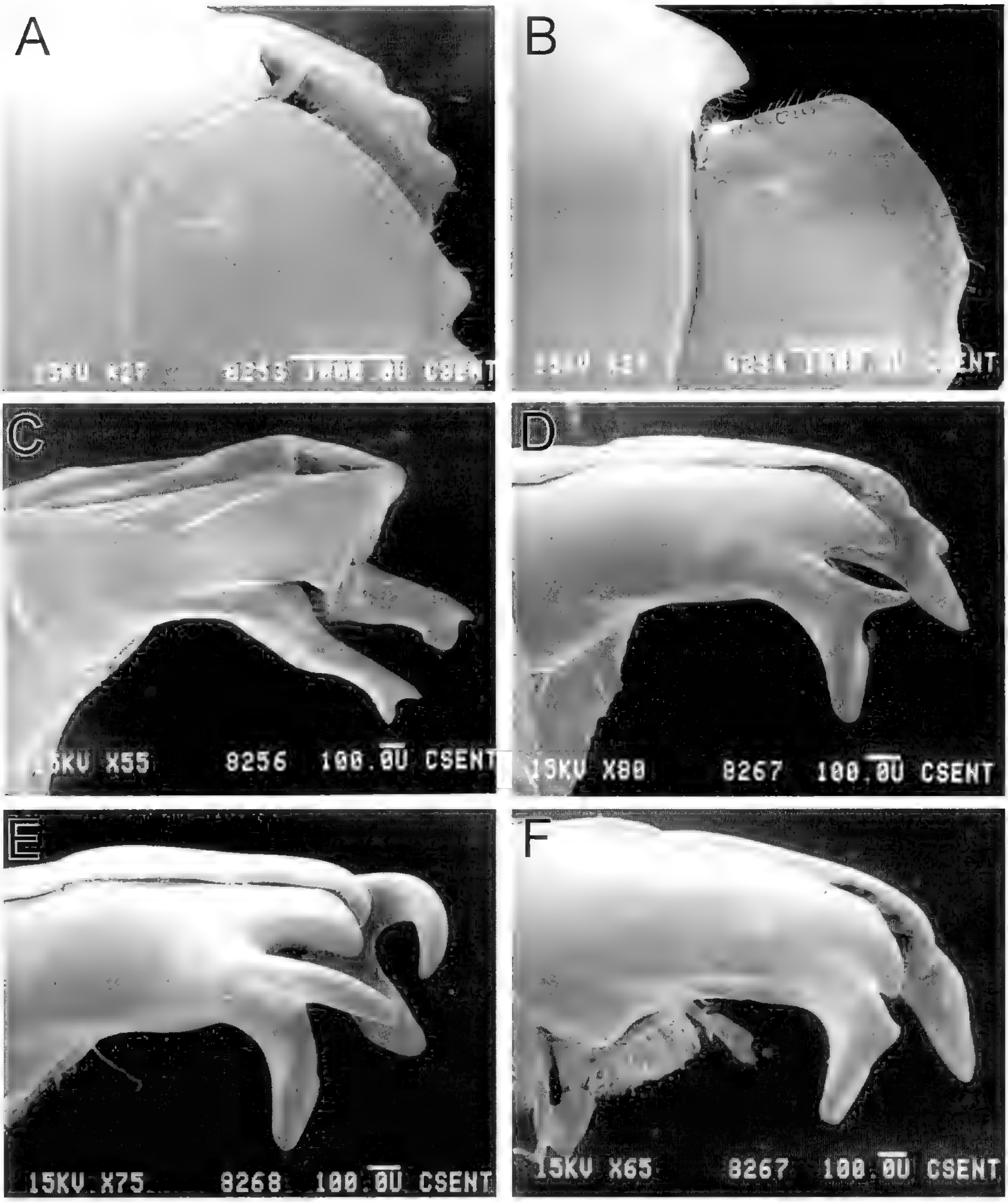

FIG. 2. *Coptodactyla* species. A-B, SEM left side head capsule: A, *matthewsi* (Iron Range); B, *nitida* (Broadwater Park); C-E, SEM apex of parameres: C, *matthewsi* (Iron Range); D, *nitida* (Cardwell Range); E, *storeyi* (Mount Webb); F, *subaenea* (McIlwraith Range).

secondary sexual characters on legs, femora with complete posterior marginal ridge, without median spur on fore tibia.

Male. Pygidium large, less than twice as broad as long (Fig. 7A), and apex last ventrite anteriorly excavate (Fig. 1B); genitalia: penis reduced to a deeply bilobed weakly sclerotised sheath (Fig.

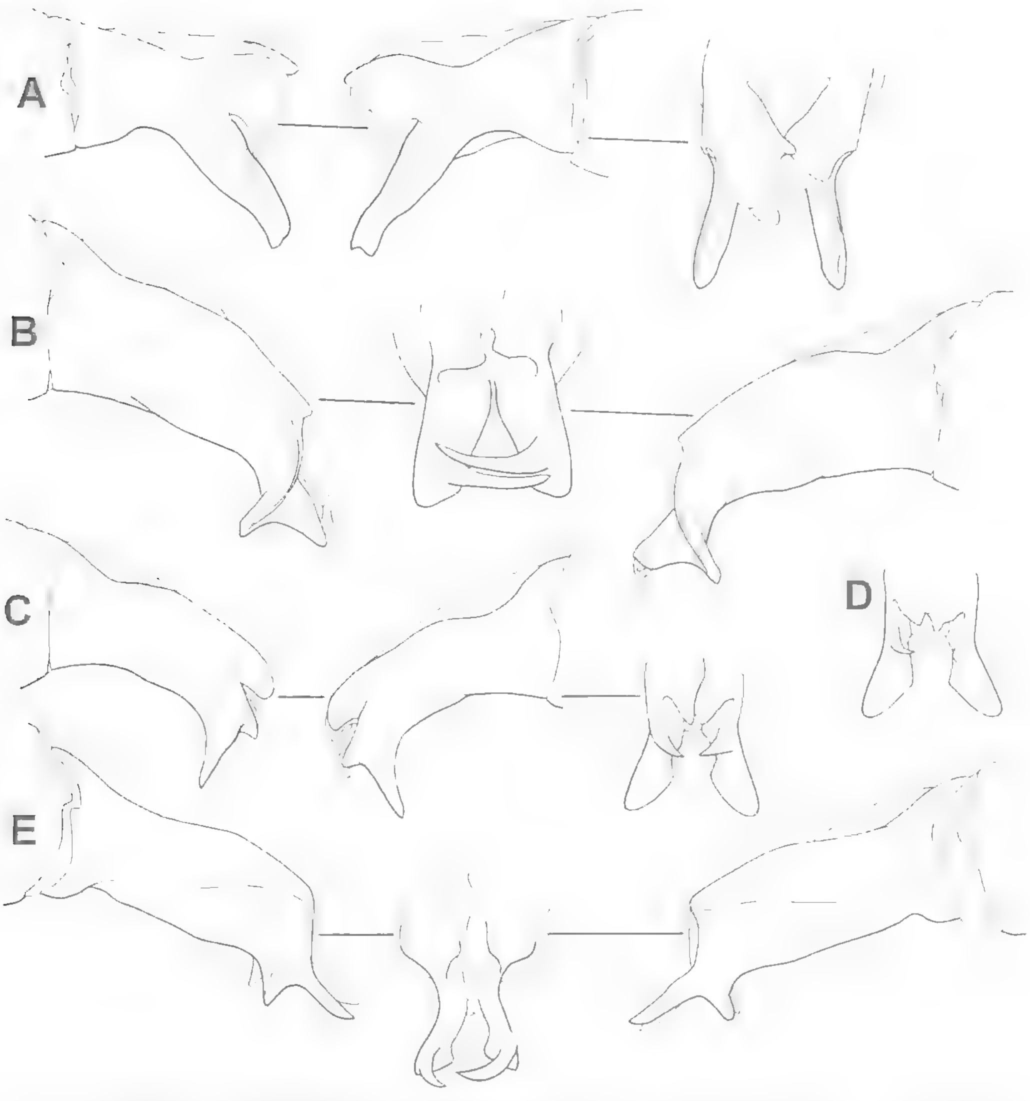

FIG. 3. *Coptodactyla* species, parameres, lateral, and apical: A, *matthewsi*; B, *merdeka*; C, *nitida* (Baldy Mountain); D, *nitida* (Paluma); E, *papua* (paralectotype). All to same scale.

5A); parameres (Figs 2C-F, 3, 4) symmetrical or almost so (rare individuals are asymmetric, Fig. 3D), apices reflexed and flattened, usually with a basal spur or tubercle; endophallus (Figs 5-6) with a single large lateral sac with patch of dense stiff spinules and usually a strongly sclerotised spine or bar; flagellum slightly curved; basal sclerite elongate rectangular, with various folds (almost identical in *C. nitida*, *C. storeyi* and *C. subaenea*); ring sclerite with two lobes, one more than twice length of other.

Female. Pygidium small, more than 2 × as broad as long (Fig. 7B), internal margin of apex deeply to shallowly excavate (Fig. 7C-H); apical margin of last ventrite evenly convex; genitalia: vulvar sclerites (Figs 8-9) either symmetrical or asymmetric, usually with broad dorsal plate; spermatheca approximately C-shaped, with weakly sclerotised 'window' at inner angle (Fig. 10).

REMARKS. *Coptodactyla depressa* Paulian, a species that does not belong to this complex, may

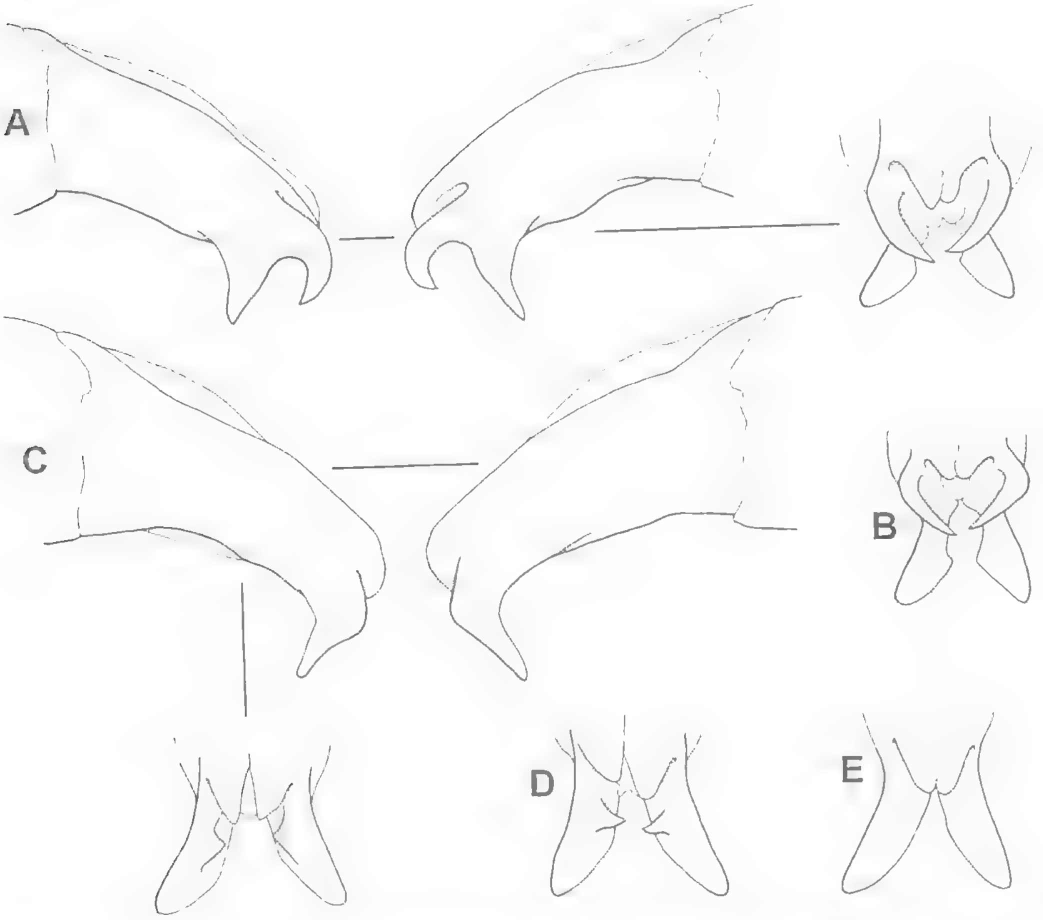

FIG. 4. *Coptodactyla* species, parameres, lateral, and apical: A, *storeyi* (Smithfield); B, *storeyi* (19km NE Mareeba); C, *subaenea* (Bald Hill); D, *subaenea* (paralectotype, Somerset); E, *subaenea* (Iron Range). All to same scale.

occasionally have the anterior pronotal border effaced in worn specimens, but can be distinguished by absence of striae 8 and 9 at elytral base, male with incomplete posterior femoral ridge, and female genitalia with dorsal sclerite reduced to an arched strut.

All species (for which there are biological data) in this complex are catholic in their choice of pabulum, being attracted to a range of decaying matter, not only faeces. Nesting biology has not been studied in this genus. All species are found in areas with at least high monsoonal rainfall, and adult activity is restricted to the rainfall months, at most from November to July, when there is softened soil. Thus late season specimens are generally more worn and duller than early season specimens. This seasonal pattern is also shown by the two species occuring in areas with continuous annual rainfall (*C. nitida* Paulian, *C. storeyi* sp. nov.), but neither is confined to such areas and both are found in a range of forest types. Only one species, *C. matthewsi* sp. nov., appears to be restricted to rainforest.

Coptodactyla matthewsi sp. nov.
(Figs 2A,C, 3A, 7C, 8A, 9A, 10A-B, 11)

ETYMOLOGY. Named for Eric Matthews, whose work has resolved the major taxonomic problems in the Australian Scarabaeinae.

MATERIAL. QUEENSLAND: Holotype, ♂: 11km NW Bald Hill, McIlwraith Ra., 13°44S 143°20E, search party

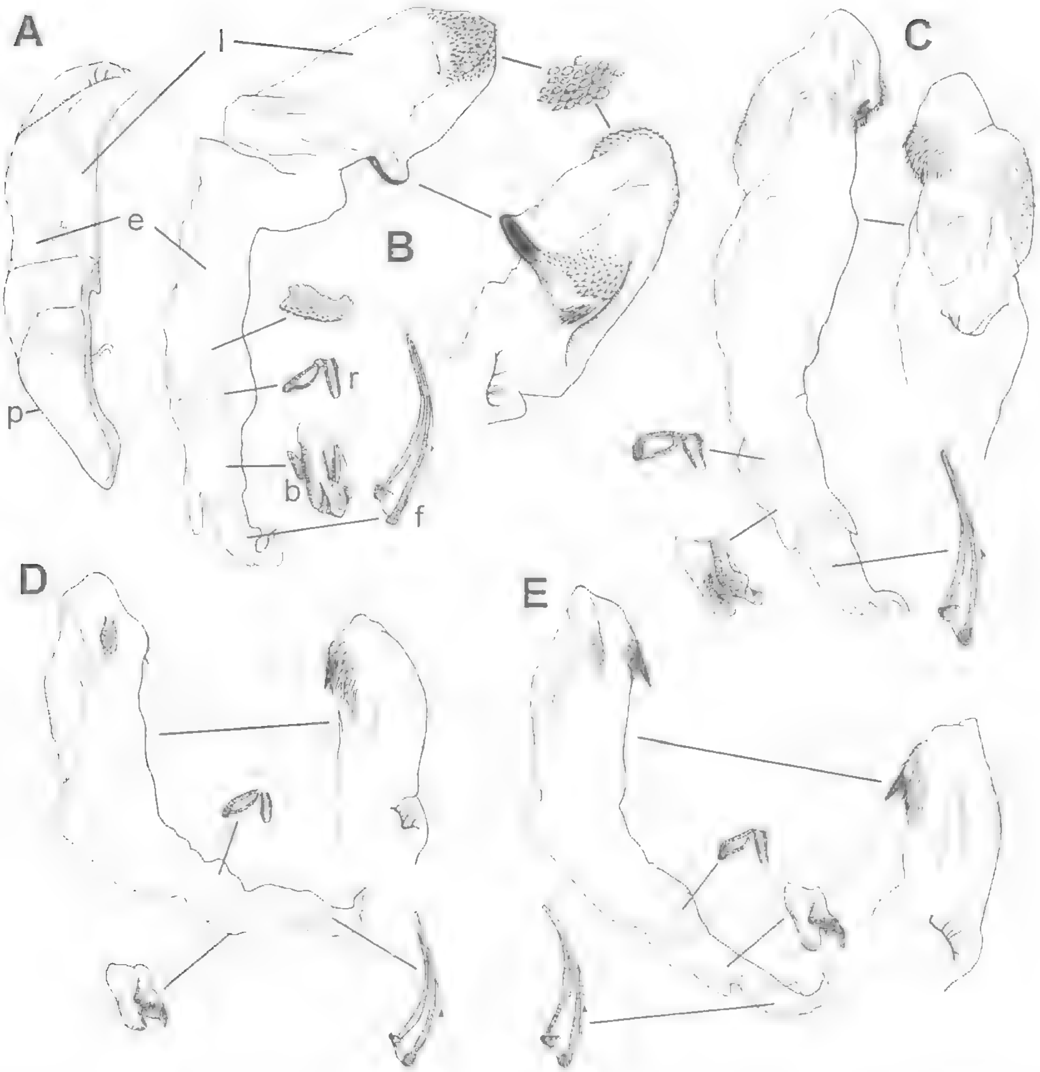

FIG. 5. Endophallus of *Coptodactyla* species. A, before removal of penis, B-E, after removal of penis and surrounding tissue and with lateral sac evaginated: A-B, *matthewsi* (Bald Hill); C, *merdeka*; D, *nitida* (Cardwell Range); E, *nitida* (Ravenshoe); b = basal sclerite; e = ejaculatory sac; f = flagellum; l = lateral sac; p = penis; r = ring sclerite. All to same scale.

campsite, human dung trap, closed forest, 520m, 27.vi-12.vii.1989, TW (ANIC). Paratypes (31) (* = specimen dissected): 2*, same data as holotype (ANIC); 3*, Iron Ra., rainforest, human dung trap, 15-21.iv.1977, RS (ANIC); 22*, Gordon's Mine area, Iron Ra., rainforest, 12-18.ii.1976, GM (QM); 2, Leo Ck Rd, McIlwraith Ra., 30km NE Coen, 500m, 29.vi-4.vii.1976, GSM (QM); 1*, West Claudie R., Iron Ra., 24.v.1974, AWH (CMN); 1, West Claudie R., Iron Ra., flight trap, rainforest, 3-10.xii.1985, GM & DC (ANIC).

DIAGNOSIS. Genal angles smooth or punctate, much more finely punctured than rugose anterior of frontoclypeus (Fig. 2A); pronotal hind angles and sides (lateral to pit and ridge) smooth and finely punctured or impunctate, without annular punctures; disc of elytra densely microreticulate; last ventrite with conspicuous annular punctures; apices of parameres with elongate, narrow, ventrally directed lobe (Figs 2C, 3A); endophallus

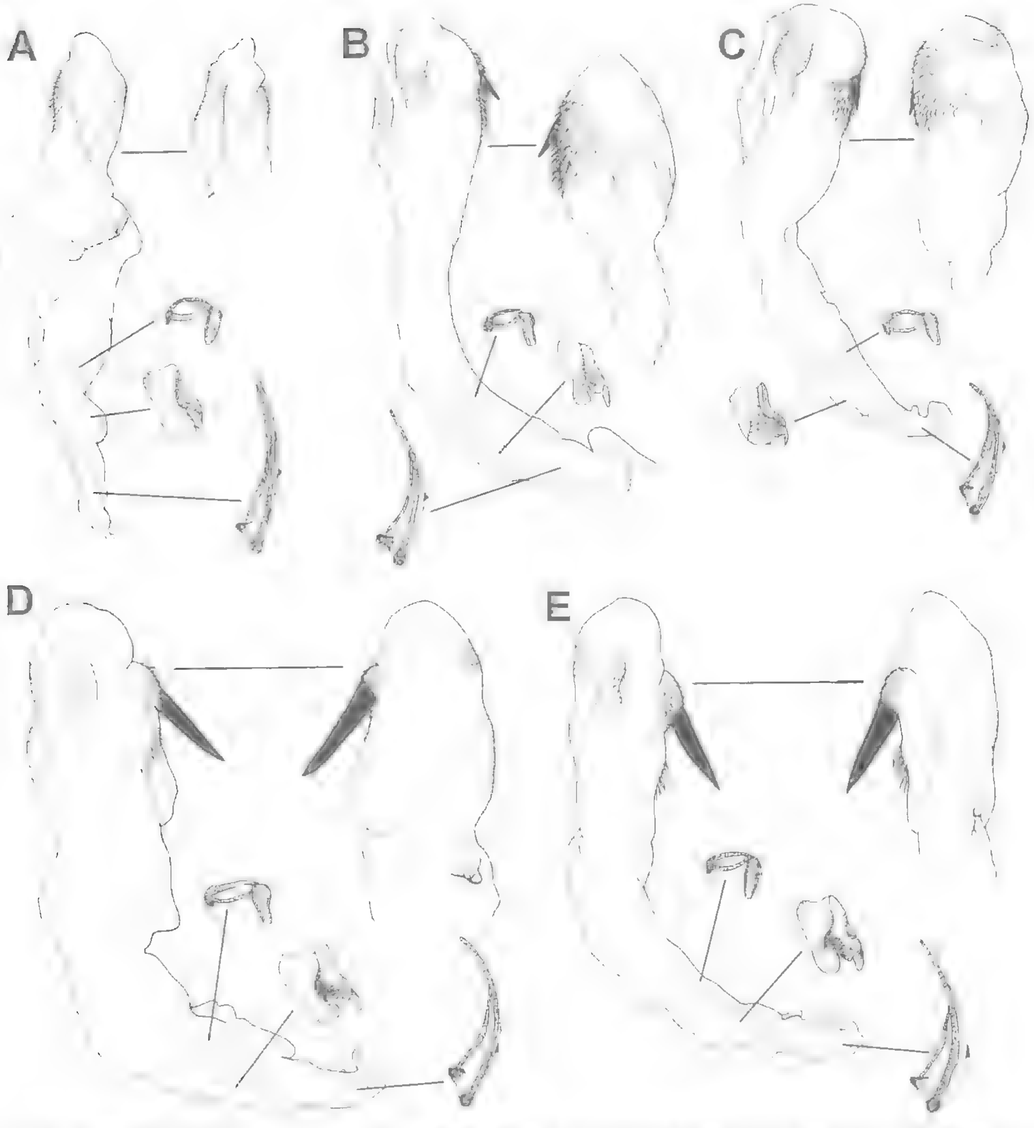

FIG. 6. Endophallus of *Coptodactyla* species, after removal of penis and surrounding tissue and with lateral sac evaginated: A, *papua*; B, *storeyi* (Mareeba); C, *storeyi* (Mount Cook); D, *subaenea* (Bamaga); E, *subaenea* (Bald Hill). All to same scale.

without apical spine on lateral sac (Fig. 5B); internal margin of female pygidium (Fig. 7C) with prominent inwardly directed lobes; ovipositor without dorsal sclerite; vulvar sclerite flat and symmetrical, without lobes (Figs 8A, 9A).

DESCRIPTION. Length: 10-13.5mm.

Head (Fig. 2A). Anterior of frontoclypeus wrinkled from line between lateral angles, except genal area finely punctured and smooth; posterior half of head increasingly finely and sparsely punctured to base, punctures much finer than pronotal disc; ventral clypeal groove shallow.

Thorax. Pronotum almost parallel-sided for most of length; pronotal disc moderately strongly punctured, interspaces 2-3 puncture diameters

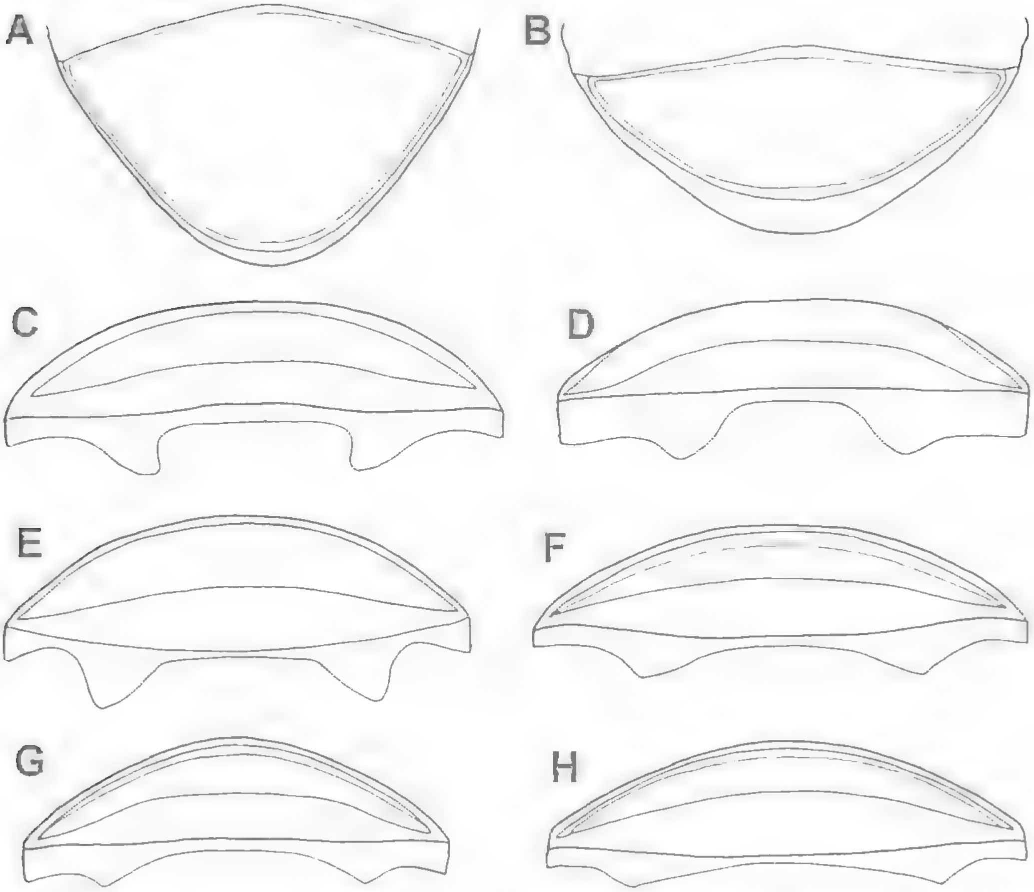

FIG. 7. *Coptodactyla subaenea*, pygidium: A, ♂; B, ♀; *Coptodactyla* species, apex of ♀ pygidium: C, *matthewsi*; D, *merdeka*; E, *papua*; F, *nitida*; G, *storeyi*; H, *subaenea*. All to same scale.

and finely micropunctate with faint microsculpture; hind angles and sides (lateral to pit and ridge) smooth and finely punctured or impunctate, without annular punctures; anterior border of pronotum lacking for 0.1-0.2× width of prothorax; elytra relatively convex in profile; elytra dull, strongly and densely microreticulate, except shining (less microsculptured), suture and 2-3 lateral intervals; elytral intervals minutely and sparsely punctured, more obviously at sides; ventral surfaces of mid and hind femora finely and sparsely punctured, without annular punctures.

Abdomen (Fig. 7C). Pygidium: male: shining, not microreticulate, minutely punctured; female: dull, strongly microreticulate, usually more evidently punctate; internal margin of female pygidium with prominent inwardly directed lobes; last ventrite with conspicuous annular punctures.

Male genitalia (Figs 2C, 3A, 5B). Apices of parameres produced as narrow straight lobes with bilobed tips; lateral sac with apical patch of stout scale-like spines, and median patch of fine spines at base of a large transverse sclerotised bar; flagellum relatively straight; basal sclerite strongly folded, with lateral lobes; secondary sclerite present in ejaculatory sac.

Female genitalia (Figs 8A, 9A, 10A-B). Dorsal sclerite absent or not strongly sclerotised; vulvar sclerite almost symmetrical, weakly sclerotised above genital opening, without erect lobe; spermatheca relatively small.

REMARKS. This species is known from isolated localities on the Iron and McIlwraith Ranges, central Cape York Peninsula (Fig. 11). There are no obvious morphological differences between the populations, which may be continuous through this rugged country. It is entirely sympatric with *C. subaenea*. All specimens were collected in rainforest, at human dung and in flight traps. Collection dates include most months from December to July, which is the monsoonal wet season.

Coptodactyla merdeka sp. nov.
(Figs 3B, 5C, 7D, 9B, 10C, 11)

ETYMOLOGY. The species name means freedom in Indonesian.

MATERIAL. INDONESIA.WEST PAPUA. Holotype, ♂: New Guinea exped., Mamberamo R., Pionierbivak, xii.1920, van Heurn (MZB). Paratypes (15): 2 ♀: same data as holotype (ANIC); 13, Timika, Freeport Concession, Irian Jaya, 11.iii.1997, R. Ubaidillah (ANIC, MZB).

DIAGNOSIS. Externally identical to *C. papua* Lansberge: pronotal hind angles and sides (lateral to pit and ridge) punctured and bordered by large annular punctures; disc of elytra not microreticulate; last ventrite with conspicuous annular punctures; parameres (Fig. 3B) without elongate lateral excavation, not laterally ridged, apices with large inwardly directed, overlapping, slightly curved spurs; lateral sac of endophallus with minute subapical sclerite (Fig. 5C); ovipositor (Fig. 9B) dorsal sclerite sharply transversely ridged, the ridge convex; vulvar sclerite approximately symmetrical, without projecting lobe; spermatheca (Fig. 10C) significantly larger than in other species.

DESCRIPTION. Length 9.5-13mm.

Head. Anterior of frontoclypeus wrinkled from line between anterior margins of eyes, except genal area strongly punctured, not wrinkled; posterior half of head moderately strongly and closely punctured, punctures stronger than on pronotal disc; ventral clypeal groove deep.

Thorax. Pronotum rounded at sides; pronotal disc finely and sparsely punctured, interspaces 3-5 puncture diameters, micropunctate but shining, without microsculpture, punctures larger and closer towards sides, separated by 1-2 diameters; hind angles and sides (lateral to pit and ridge) punctured and bordered by large annular punctures; anterior border of pronotum lacking for 0.2 × width of prothorax; base of lateral part of hypomeron with one or more annular punctures; elytra relatively flat in profile; elytra shining, not microreticulate, intervals finely and sparsely punctured, not more obviously at sides; ventral surfaces of mid and hind femora with numerous annular punctures and large punctures.

Abdomen (Fig. 7D). Pygidium: shining, not microreticulate, disc finely punctured to impunctate; last ventrite with conspicuous annular punctures; internal margin of female pygidial apex deeply excavate.

Male genitalia (Figs 3B, 5C). Parameres without elongate excavation, not laterally ridged, apices flat and strongly deflexed, with long, inwardly directed, overlapping, slightly curved spurs; lateral sac of endophallus with a dense median brush of small stiff spines around small flat sclerite; flagellum relatively straight; basal sclerite quadrangular, with strong median fold and basal lobes.

Female genitalia (Figs 9B, 10C). Dorsal sclerite sharply transversely ridged, ridge convex; vulvar plate almost symmetrical, generally weakly sclerotised, produced above genital opening as a weak ridge; spermatheca relatively large, C-shaped.

REMARKS. This species is known from 16 specimens collected in West New Guinea (Fig. 11), 3 of which had been identified as *C. papua* by Gillet in 1925. The specimens taken at Timika were collected at 100m, in 'dry lowland forest'. The habitat at the lowland riverplain of Pionierbivak is unknown.

Coptodactyla nitida Paulian, stat. rev.
(Figs 2B,D, 3C-D, 5D-E, 7F, 8B, 9C-D, 10D-E, 12)

Coptodactyla nitida Paulian 1933: 70; Matthews 1976: 32, jun. syn. of *C. subaenea* Harold.

MATERIAL. QUEENSLAND: Holotype, ♀: Nov.Holl.Queensld, Fry coll. 1905-100 (BMNH). OTHER MATERIAL. (951) (* = specimen dissected; label data abbreviated to site, altitude, date & collector): QUEENSLAND: 88*, Atherton, 7.v.1964, 23-26.iii.1965, 9-12.ii.1975, Bornemissza, HAH (ANIC, CMN); 1, 4mi. S Atherton, 18.ii.1975, HAH (CMN); 3, Bally Knob, 1100m, 6.xii.1998-6.ii.1999, GM & DC (QM); 95*, Baldy Mt. Rd, 860m, 1120-1130m, 30.xi.1997-12.ii.1998, 3-6.ii.1999, GM & DC (QM); 1, Balgal Bch, 5m, 4-12.ii.1998, GM & DC (QM); 1*, Bilyana, 30m, 4-12.ii.1998, GM & DC (QM); 1*, Broadwater Park, 35km NW Ingham, 22.xii.1986, Hamlet (QM); 11, Cardwell Gap, 120m, 4-12.ii.1998, GM & DC (QM); 7, 5km N Cardwell Gap, 10m, 4-12.ii.1998, GM & DC (QM); 10*, Cardwell Ra., 2.v.1964, GB (ANIC); 26, Crystal Ck, 20.iii.1965, GB (ANIC); 40*, Damper Ck, 10m, 4-12.ii.1998, GM & DC (QM); 1, Five Mile Ck, 10m, 16-25.iv.1999, CR (ANIC); 141*, Gillies Hwy, Heales Lookout, 30.iii.1965, 7.v.1969, GB, PF (ANIC); 1, 3mi N Herberton, 14.ii.1976, RS (DPIM); 1*, 7mi SW Herberton, 6.xii.1968, EB (ANIC); 14*, Hinchinbrook I.,

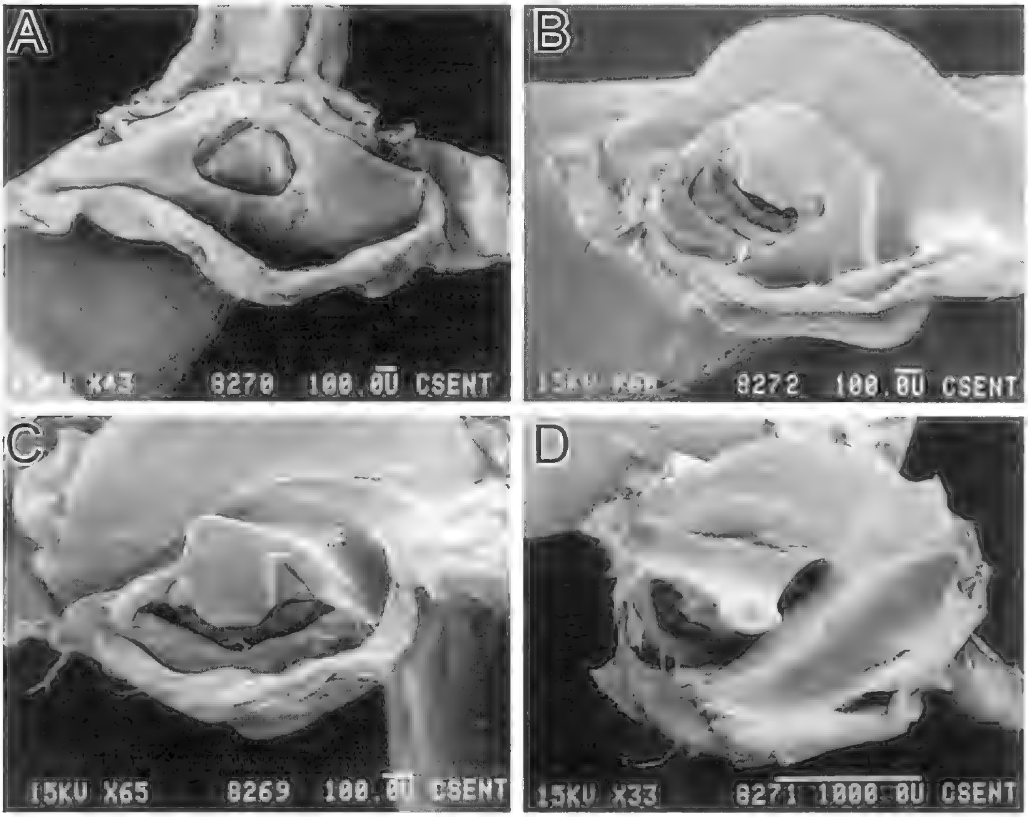

FIG. 8. *Coptodactyla* species, SEM vulvar sclerites: A, *matthewsi* (Iron Range); B, *nitida* (Paluma); C, *storeyi* (Mount Cook); D, *subaenea* (McIlwraith Range).

Gayundah Ck, 10m, 8-18.xi.1984, GM, GT & DC (QM); 1*, 19km N Ingham, 25-26.ii.1976, RS (DPIM); 4, Kirrama, Cardwell Ra., 600m, 25.iv.1997, CR (ANIC); 31, Kirrama Ra., 700m, 4.ii.1970, 29.xii.1986, Ey, HAH (ANIC, CMN); 14*, Little Crystal Ck, 30.v.1969, PF, Huppatz (ANIC); 9, Mill Ck, 940-1030m, 5-9.ii.1999, GM & DC (QM); 24*, Millstream Falls, 1040m, 5-7.xii.1998, 4-9.ii.1999, GM & DC (QM); 6*, Mt Collins, Cardwell Ra., 26-27.iv.1997, CR (ANIC); 1, Mt Haig, 17-21.iv.1994, Morse (ANIC); 1, Mt Speculation, 4.i.1967, JGB (ANIC); 87, Paluma, 20.iii.1965, GB (ANIC); 28, 5mi E Paluma, Saddle Camp, 1700', 14.v.1969, 18.i.1970, GB, EB & SM (ANIC); 1, 14km N Paluma, 850m, 11.ii.1971, JGB (ANIC); 5, c6km W Paluma, 9-11.i.1969, JGB (ANIC); 53*, c.9km W Paluma, 2600-2900', 16-18.i.1970, 4-13.xii.1973, 10.i.1989, EB, SM, JGB, RS (ANIC, DPIM); 18*, c12km W Paluma, 11.i.1964, 9-11.i.1969, 10.i.1989, JGB, HAH (ANIC, CMN); 1, 7mi NNE Ravenshoe, 22.iv.1969 (ANIC); 70, 2-3km SW Ravenshoe, 860-880m, 5-7.xii.1998, 3-8.ii.1999, GM (QM); 48, 3km SE Ravenshoe, 960m, 5-11.ii.1998, 4-6.ii.1999, GM & DC (QM); 1*, 4km SSE Ravenshoe, 920m, 5-11.ii.1998, GM & DC (QM); 1, 2-17mi W Ravenshoe, 1.iv.1968, Matthews (ANIC); 3*, Tully, 3.v.1965, GB (ANIC); 1, 5mi W Tully, 23.iv.1955, Norris & Common (ANIC); 29*, 2km SW Tully Falls, 760m, 2.xii.1998-4.ii.1999, GM & DC (QM); 36, 2.5km NW-3.5km N Tumoulin, 980-1020m, 4-5.ii.1999, GM, DC (QM); 12*, Wallaman Falls, 620m, 5-12.ii.1996, GM (QM); 2*, Watsonville, 7-14.ii.1976, RS (DPIM); 1*, Webster Rd, Evelyn, 990m, 5-11.ii.1998, GM & DC (QM); 18, 2km SSE Wondecla, 910m, 3-6.ii.1999, GM & DC (QM); 2, Yungaburra, 27.iii.1965, GB (ANIC).

DIAGNOSIS. Externally identical to *C. subaenea* Harold and *C. storeyi* sp. nov.: pronotal hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures; disc of elytra not microreticulate; last ventrite impunctate, without conspicuous annular punctures; apical lobes of parameres (Figs 2D, 3C-D, 12) with sharp incurved short spine; lateral sac of endophallus (Fig. 5D-E) with small apical spine, 0.3-0.5× width of sac, less densely spiculate at base of this than *C. storeyi*; vulvar sclerite (Figs 8B, 9C-D) asymmetric with small rounded projecting lobe.

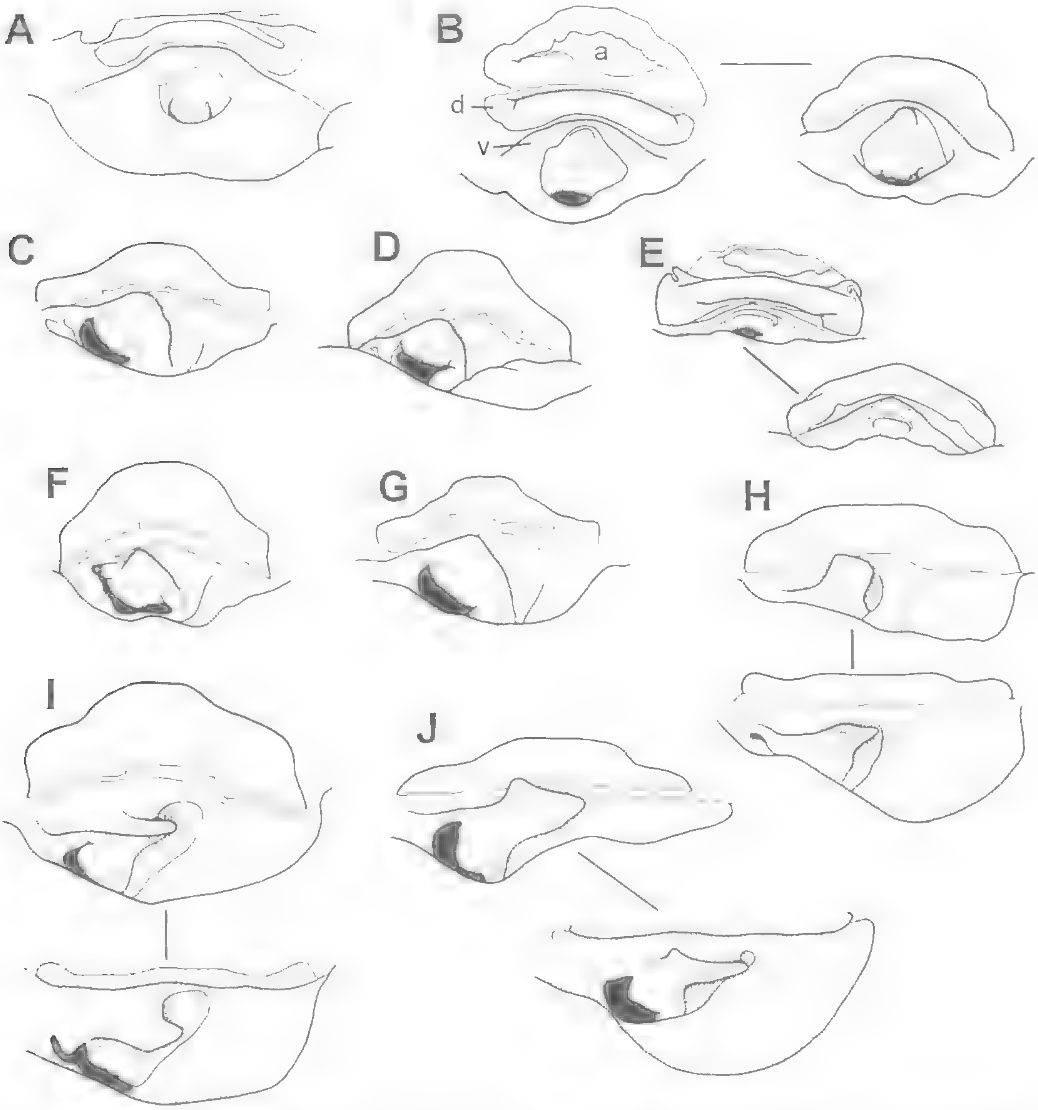

FIG. 9. *Coptodactyla* species, vulvar sclerites: A, *matthewsi* (Bald Hill); B, *merdeka*; C, *nitida* (holotype, Queensdland); D, *nitida* (Gillies Highway); E, *papua*; F, *storeyi* (Mount Cook); G, *storeyi* (Black Mountain); H, *subaenea* (paralectotype, Somerset); I, *subaenea* (Mount Tozer); J, *subaenea* (Heathlands); a = anus; d = dorsal sclerite; v = vulvar sclerite. All to same scale.

DESCRIPTION. Length: 8-12.5mm.

Head (Fig. 2B). Anterior of frontoclypeus wrinkled from line between anterior margins of eyes, including genal angles; posterior half of head moderately strongly and closely punctured, punctures similar to pronotal disc; ventral clypeal groove deep.

Thorax (Fig. 2B). Pronotum rounded at sides; pronotal disc strongly punctured, interspaces 1-2 puncture diameters, micropunctate but shining, without microsculpture, punctures finer and sparser at base; hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures; anterior border of pronotum lacking for 0.25-0.4 × width of prothorax; base of lateral part of hypomeron without annular punctures; elytra relatively flat in profile; elytra shining, not microreticulate, intervals finely and sparsely punctured, not more obviously at sides; apical half of ventral surfaces of mid and hind femora with annular punctures and fine punctures.

Abdomen (Fig. 7F). Pygidium: shining, not microreticulate, disc finely punctured to impunctate; last ventrite impunctate, without conspicuous annular punctures; internal margin of female pygidial apex shallowly excavate.

Male genitalia (Figs 2D, 3C-D, 5D-E). Apices of parameres strongly deflexed as a flat lobe with sharp inwardly directed triangular tubercle or curved spur at base; lateral sac with dense patch of stiff spines at base of relatively short black spine, less than half width of sac; flagellum relatively curved; basal sclerite quadrangular, with strong median fold and basal lobes.

Female genitalia (Figs 8B, 9C-D, 10D-E). Dorsal sclerite flat and broad, without sharp transverse ridge; vulvar sclerite strongly asymmetric, produced above genital opening as a smoothly rounded lobe; spermatheca relatively small.

Intraspecific variation. The size of the spines on the apex of the parameres does not vary clinally (Fig. 12) but may vary between parameres (Fig. 3D). In all specimens the spines are inwardly directed and appear as a triangular process in profile. The spine of the endophallus varies in size (Figs 5D-E), overlapping with that of *C. storeyi*, but the basal patch of spicules is generally less extensive. The shape of the vulvar plate varies slightly (Figs 8B, 10D-E), but the lobe is consistently less angular than in *C. storeyi*.

REMARKS. Paulian distinguished *C. nitida* by its shining upper surface, but this is characteristic of all freshly emerged specimens of *Coptodactyla* species (except *C. matthewsi*), which become extremely scratched and dull with age. The female holotype has been dissected to confirm its identity (Fig. 9C).

The species is the southernmost member of the *subaenea*-complex, found from just south of Mareeba on the Atherton Tableland, to Bluewater State Forest at the southern end of the Paluma Range (Hill 1993, as *C. subaenea*), from 5 to 1120m above sea level (Fig. 12). It is entirely allopatric with respect to the neighbouring *C. storeyi*, although the two species occur within 5km of each other, south-east of Mareeba. Hill (1996) noted that *C. nitida* (as *C. subaenea*) is nocturnal, attracted to light, characteristic of open *Eucalyptus* and *Allocasuarina* forest but also occuring in rainforest, and found at a variety of baits (mushroom, liver, dung, banana). Specimens I have seen were collected in open woodland or wet sclerophyll (tall eucalypt) forest, rarely rainforest, in areas of relatively high rainfall, at dead fish, fungi, human or cow dung, or at light and in flight traps. This species has been collected in every month from November (once) to May, which is the duration of the monsoonal wet season.

Coptodactyla papua Lansberge
(Figs 3E, 6A, 7E, 9E, 10F, 11)

Coptodactyla papua Lansberge 1885: 393

MATERIAL. Lectotype (here designated), ♂: PAPUA NEW GUINEA: labelled: 'Nuova Guinea, Fly River, 1876-77, L. M. D'Albertis' and 'syntypus *Coptodactyla papua* Lansberge, 1885', (MCG). Paralectotypes (3): ♂, 2♀, same data as lectotype (MCG). Lansberge (1885) did not indicate how many specimens were available to him. The types listed here are labelled 'syntypus, *Coptodactyla papua* Lansberge, 1885' and two are additionally labelled 'typus'.

DIAGNOSIS. Externally identical to *C. merdeka*; pronotal hind angles and sides (lateral to pit and ridge) punctured and bordered by large annular punctures; disc of elytra not microreticulate; parameres laterally ridged above elongate excavation, apices flat and strongly deflexed, with large projecting and only slightly incurved basal spurs (Fig. 3E); lateral endophallic sac without subapical spine (Fig. 6A); ovipositor dorsal sclerite (Fig. 9E) sharply transversely ridged, ridge shallow and angular; vulvar sclerite approximately symmetrical, without projecting lobe.

DESCRIPTION. Length 10.5-11.5mm.

Head. Anterior of frontoclypeus wrinkled from line between anterior margins of eyes, except genal area strongly punctured, not wrinkled; posterior half of head moderately strongly and closely punctured, punctures stronger than on pronotal disc; ventral clypeal groove deep.

Thorax. Pronotum rounded at sides; pronotal disc finely and sparsely punctured, interspaces 3-5 puncture diameters, micropunctate but shining, without microsculpture, punctures larger and closer towards sides, separated by 1-2 diameters; hind angles and sides (lateral to pit and ridge) punctured and bordered by large annular punctures; anterior border of pronotum lacking for 0.2 × width of prothorax; base of lateral part of hypomeron with one or more annular punctures; elytra relatively flat in profile; elytra

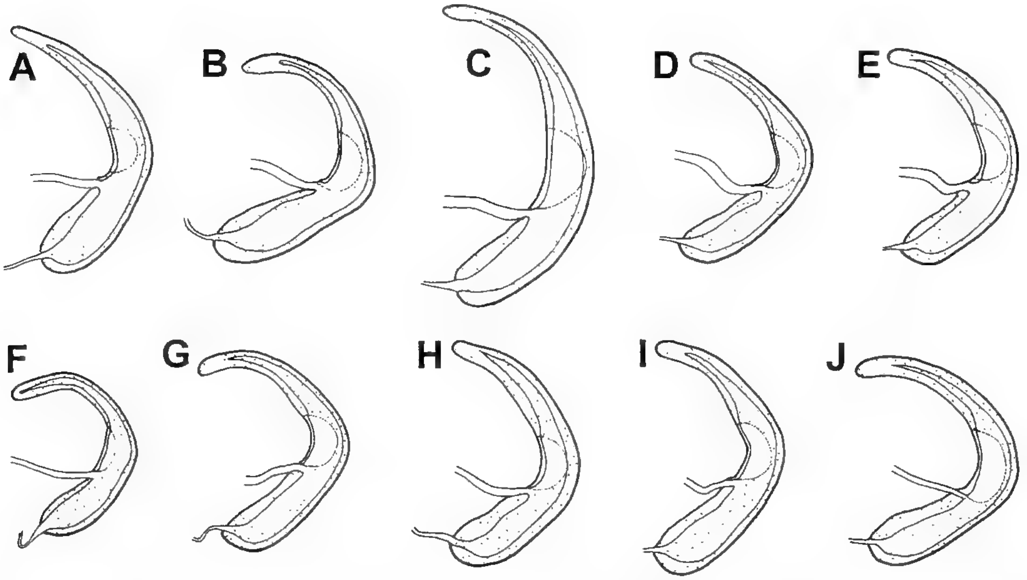

FIG. 10. *Coptodactyla* species, spermatheca: A, *matthewsi* (Iron Range); B, *matthewsi* (Bald Hill); C, *merdeka*; D, *nitida* (Gillies Highway); E, *nitida* (Paluma); F, *papua*; G, *storeyi* (Mount Lewis); H, *storeyi* (Mount Cook); I, *subaenea* (Bald Hill); J, *subaenea* (Mount Tozer). All to same scale.

shining, not microreticulate, intervals finely and sparsely punctured, not more obviously at sides; ventral surfaces of mid and hind femora with numerous annular punctures and large punctures.

Abdomen (Fig. 7E). Pygidium: shining, not microreticulate, disc finely punctured to impunctate; last ventrite with conspicuous annular punctures; internal margin of female pygidial apex deeply excavate.

Male genitalia (Figs 3E, 6A). Parameres laterally ridged above elongate excavation, apices flat and strongly deflexed, with large projecting and only slightly incurved basal spurs (Fig. 4D); lateral sac of endophallus with a dense median brush of small stiff spines, without strongly sclerotised spine; flagellum relatively straight; basal sclerite quadrangular, with strong median fold and basal lobes.

Female genitalia (Figs 9E, 10F). Dorsal sclerite sharply transversely ridged, but stout, about as broad as deep; vulvar plate almost symmetrical, generally weakly sclerotised, produced above genital opening as a weak ridge; spermatheca relatively small, strongly C-shaped.

REMARKS. This species is known from just the four type specimens, habitat unknown. They were collected by D'Albertis in either November-December 1875 or May-July 1876, within 580km of the mouth of the Fly River (Goode, 1977) (Fig. 11).

Coptodactyla storeyi sp. nov.
(Figs 2E, 4A-B, 6B-C, 7G, 8C, 9F-G, 12)

ETYMOLOGY. This species is named for Ross Storey, as thanks for help rendered and in recognition of his contribution to knowledge of Australia's tropical Coleoptera..

MATERIAL. QUEENSLAND: Holotype, ♂ (QMT 93003, in QM): Hann Tbld (north end), 16°49S 145°11E, pitfalls, open forest, 950m, 11-13.xii.1995, GM. Paratypes (367): (* = specimen dissected; label data abbreviated to site, altitude, date & collector): 4, Abbatoir Swamp, 350m, 24-25.xi.1998, GM (QM); 12*, same data as holotype (QM); 3*, Bakers Blue Mt., 17km W Mt Molloy, 1100m, 30.xii.1989-18.i.1990, GM (QM); 1*, Black Mt. Rd, c.17km N Kuranda, 12.v.1970, JGB (ANIC); 9, 1km NW Buchan Pt, 5m, 14-18.v.1998, 11-13.ii.1999, GM (QM); 1*, C. Tribulation, 10m, 12-15.vii.1982, S. & J. Peck (ANIC); 6*, 47km NE [sic, by road] Cooktown, 23.xii.1979, RS (ANIC, DPIM); 1*, 16km up Davies Ck Rd, 18.i-2.ii.1983, RS & Titmarsh (DPIM); 2*, Davies Ck, 21.ii.1981, RS (DPIM); 2*, Douglas Ck, 15km SE Mareeba, 630m, 6-10.ii.1998, GM & DC (QM); 3, Emmagen Ck, 10m, 17-19.xi.1998, GM (QM); 32*, Hann Tbld, 13km WNW Mareeba, 17.ii-20.iii.1989, 5.xi-8.xii.1993, 8.xii.1993-13.i.1994, 1.iii-12.iv.1994, RS, Dickinson, De Faveri (DPIM); 3*, Hann Tbld, north end, 950-1000m, 11-14.xii.1995, GM, GT & DC (QM); 31, Hann Tbld, 3km SSW Tower, 700m, 26-27.xi.1998, GM

(QM); 17, ditto, Radar Station, 950m (QM); 44, 2.5-4km S Hartleys Ck, 5-10m, 14-18.v.1998, 3-11.ii.1999, GSM, DC (QM); 4*, Hazelmere Station, 24km WNW Cooktown, 8.v.1981, JF (ANIC); 1*, Home Rule area, 300-400m, 7-8.i.1991, GM (QM); 3, 14km NW Hope Vale Mission, 7-10.v.1981, JF (ANIC); 1*, Julatten, 10.iv.1978, AWH (CMN); 1, 9km NE Julatten, 26.xii.1986-8.i.1987, HAD (CMN); 1*, 2km ENE Kuranda, 360m, 19-21.iv.1999, CR & I. Reid (ANIC); 1*, 19km NE Mareeba, 12.ii-20.iii.1985, RS & Halfpapp (DPIM); 5*, 19.5km ESE Mareeba, 24.xii.1986, 3.i.1987, RS (DPIM); 3*, Mary Ck, 5.xii.1968, EB & SM (ANIC); 1*, Mt Cook NP, 10-12.v.1981, JF (ANIC); 1, Mt Finnigan, 37km S Cooktown, 850-1100m, 19-22.iv.1982, GM, DY & DC (QM); 24, 4km WNW Mt Molloy, 350m, 24-25.xi.1998, GM (QM); 2, Mt Webb, 10.v.1986, Holm (ANIC); 12*, 3km NE Mt Webb, 30.iv-3.v.1981, JF (ANIC); 9, Noah Bch, 10m, 26.xii.1997-7.i.1998, Grove (QM); 4, Oak Bch, 5m, 3-11.ii.1999, GM & DC (QM); 4, 4.5km W Port Douglas, 10m, 3-11.ii.1999, GM, DC (QM); 4*, top of Quaid Rd, 5.i-9.ii.1998, DeFaveri & Halfpapp (DPIM); 11, Rex Ra., 50-90m, 15-18.v.1998, 3-11.ii.1999, GSM, DC (QM); 9*, Shiptons Flat, 220m, 19-22.xi.1998, GM (QM); 13*, Smithfield, 20m & 100m, vi.1997, 3-4.i.1998, CR (ANIC); 29*, Upper Station Ck, 350-370m, 6-9.ii.1998, 23-25.xi.1998, 3-11.ii.1999, GM & DC (QM); 51*, Windsor Tbld, 28km NNW Mt Carbine, 850-900m, 15-18.iv.1982, 20.xii.1985-15.i.1986, 25.xi.1997-9.ii.1998, 9.ii-17.v.1998, RS, Brown, GM, DC, DY (DPIM, QM).

DIAGNOSIS. Externally identical to *C. subaenea* Harold and *C. nitida* Paulian: hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures; disc of elytra not microreticulate; apical lobes of parameres with large projecting and down-curved spine (Figs 2E, 4A-B, 12); lateral sac of endophallus (Fig. 6B-C) with small to moderately long apical spine, 0.3-0.5 × sac width and larger patch of basal spicules than *C. nitida*; last ventrite impunctate, without conspicuous annular punctures; vulvar sclerite (Figs 8C, 9F-G) asymmetric with small, angular, projecting lobe.

DESCRIPTION. Length: 8.5-13mm.

Head. Anterior of frontoclypeus wrinkled from line between anterior margins of eyes, including genal angles; posterior half of head moderately strongly and closely punctured, punctures similar to pronotal disc; ventral clypeal groove deep.

Thorax. Pronotum rounded at sides; pronotal disc strongly punctured, interspaces 1-2 puncture diameters, micropunctate but shining, without microsculpture, punctures finer and sparser at base; hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures; anterior border of pronotum lacking for 0.25-0.4 × width of prothorax; base of lateral part of hypomeron without annular punctures; elytra relatively flat in profile; elytra shining, not microreticulate, intervals finely and sparsely punctured, not more obviously at sides; apical half of ventral surfaces of mid and hind femora with annular punctures and fine punctures.

Abdomen (Fig. 7G). Pygidium: shining, not microreticulate, disc finely punctured to impunctate; last ventrite impunctate, without conspicuous annular punctures; internal margin of female pygidial apex shallowly excavate.

Male genitalia (Figs 2E, 4A-B, 6B-C, 12). Apices of parameres strongly deflexed as a flat lobe with large strongly curved spur at base, directed obliquely inwards; lateral sac with dense brush of fine stiff spicules around a large black spine, less than half width of sac; flagellum relatively curved; basal sclerite quadrangular, with strong median fold and basal lobes.

Female genitalia. Dorsal sclerite flat and broad, without sharp transverse ridge; vulvar sclerite strongly asymmetric, produced above genital opening as a right-angled or more acute, generally triangular, lobe (Figs 3A, 9F-G); spermatheca relatively small (Fig. 10G-H).

Intraspecific variation. The large apical spines on the parameres are relatively uniform in size across the range of *C. storeyi*, constantly strongly curved and down-turned in profile (Figs 2E, 4A-B, 12). The lobe of the vulvar sclerite varies in shape, but is always angulate (Figs 8C, 9F-G). The subapical spine of the lateral endophallic sac (Fig. 6B-C) varies in size, overlapping with *C. nitida*, but the patch of basal spiculae is generally larger.

REMARKS. The species occurs from just south of Mareeba at Davies Creek north to Cape Flattery (Fig. 12). It is entirely allopatric with respect to the neighbouring *C. nitida*, although the two species occur within 5km of each other, though at different altitudes, southeast of Mareeba. *Coptodactyla storeyi* has been collected from horse, cow and human dung, dead fish, fungi, flight intercept traps and at light. It commonly occurs in rainforest, but also *Eucalyptus* and *Allocasuarina* open forest, in areas of relatively high rainfall, from 5 to 1100m above sea level. The species has been collected in every month from December to May, and July (once).

Coptodactyla subaenea Harold
(Figs 1, 2F, 4C-E, 6D-E, 7H, 8D, 9H-J, 10I-J, 11)

Coptodactyla subaenea Harold 1877: 40; Matthews 1976: 32.

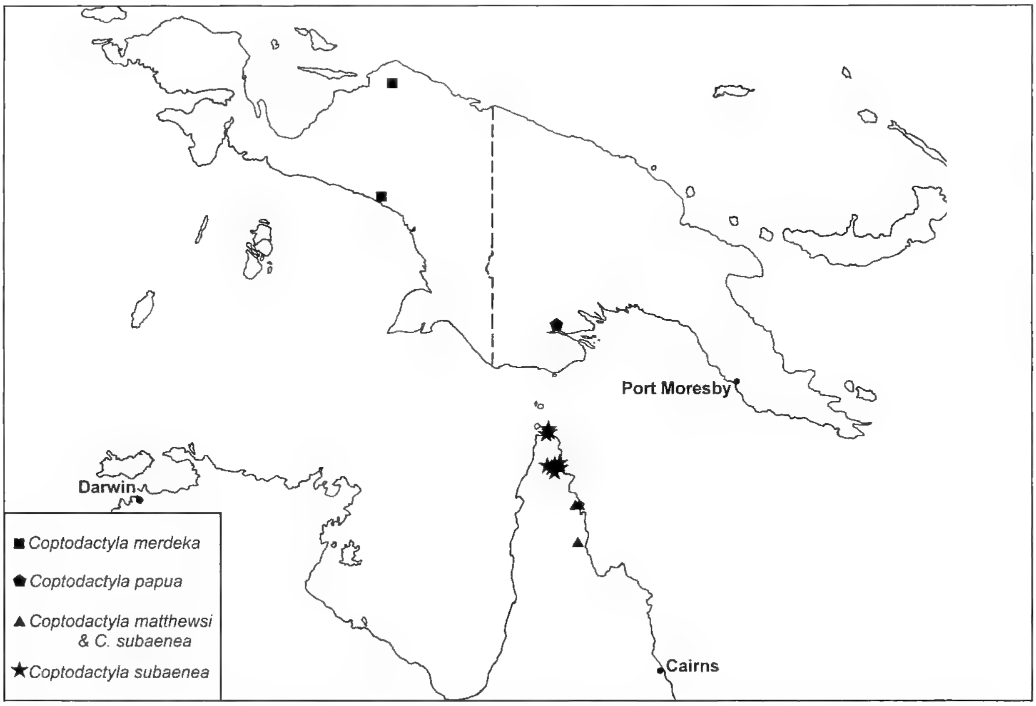

FIG. 11. Map of North Queensland and New Guinea, showing distribution of *Coptodactyla* species.

MATERIAL. QUEENSLAND: Lectotype, ♂ (here designated): labelled: 'Somerset, i.1875, D'Albertis' and 'syntypus *Coptodactyla subaenea* Harold, 1877' (MCG). Paralectotypes (4): 3♂, ♀, same data as lectotype (MCG). Harold did not indicate how many specimens were available for his description. The types listed here are all labelled 'syntypus, *Coptodactyla subaenea* Harold 1877' and two are additionally labelled 'typus'. OTHER MATERIAL. (365) (* = dissected; label data abbreviated to locality, altitude, date, collector): 23*, 11km NW Bald Hill, McIlwraith Ra., 520m, 27.vi-12.vii.1989, TW (ANIC); 1, C. York, ex Macleay Museum (ANIC); 8, Captain Billy Ck, 9-13.vii.1975, GM (QM); 71*, 15km W Captain Billy Ck, 4-9.vii.1975, 5-12.ii.1976, GM (QM); 1, 3km WNW Captain Billy Landing, 3.iv.1993, PZ (ANIC); 23, Cockatoo Ck, 7.ii-23.v.1993, 14.xii.1993-21.i.1994, PZ, Roach (ANIC); 49*, Gordons Mine area, Iron Ra., 12-19.ii.1978, GM (QM); 57*, Heathlands, 15.i-29.ii.1992, 8.xii.1992-19.ii.1993, 24-28.ii.1993, 14.xii.1993, Feeney, TW, PZ (ANIC); 30, 14-15km ENE Heathlands, 15-26.i.1992, 26-28.ii.1993, 14.xii.1993, 19.iii.1994, TW, Calder, PZ (ANIC); 11, 12km NE Heathlands, 15-26.i.1992, TW (ANIC); 11*, 17km NW Heathlands, 15-26.i.1992, 1.iii-25.iv.1992, TW, Feeney, McLeod (ANIC); 14*, 12km SSE Heathlands, 15-26.i.1992, TW, Naumann (ANIC); 1*, Iron Ra., 26.xi.1985, Ferguson (ANIC); 45*, Lake Boronto, Newcastle Bay, 30.i-4.ii.1975, GM (QM); 2*, Leo Ck Rd, McIlwraith Ra., 29.vi-4.vii.1976, GSM (QM); 1*, Lockerbie, 3.iv.1964, Common, Upton (ANIC); 10*, 3-4 km E Lockerbie, 30.i-4.ii.1975, 19-23.iii.1987, GM (QM); 1*, 3km ENE Mt Tozer, 1-4.vii.1986, TW (ANIC); 1*, Quinn Park, Claudie R., 12-21.ii.1985, Edwards, Hacobian (ANIC); 5*, West Claudie R., Iron Ra., 24.v.1974, AWH (CMN).

DIAGNOSIS. Externally identical to *C. nitida* Paulian and *C. storeyi* sp. nov.: pronotal hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures (Fig. 1A); disc of elytra not microreticulate; last ventrite impunctate, without conspicuous annular punctures (Fig. 1B); apical lobes of parameres with sharp incurved short spine, blunt tubercle, or slight basal convexity (Figs 2F, 4C-E); lateral sac of endophallus with massive strongly sclerotised spine, 0.75-1 × width of sac (Fig. 6D-E); vulvar sclerite strongly asymmetric, produced above genital opening as a thin quadrate lobe (Figs 8D, 9H-J).

DESCRIPTION. Length 9-13mm.

Head (Fig. 1). Anterior of frontoclypeus wrinkled from line between anterior margins of eyes, including genal angles; posterior half of head moderately strongly and closely punctured,

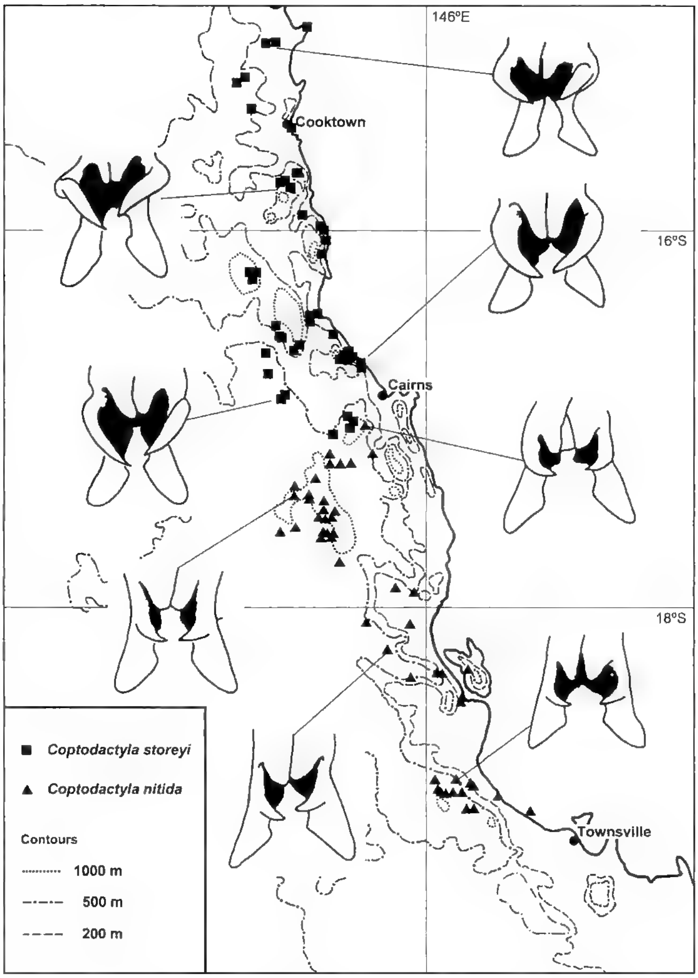

FIG. 12. Map of North Queensland, showing distribution of *Coptodactyla nitida* and *C. storeyi* with shape of paramere apices at various sites.

punctures similar to pronotal disc; ventral clypeal groove deep.

Thorax (Fig. 1). Pronotum rounded at sides; pronotal disc strongly punctured, interspaces 1-2 puncture diameters, micropunctate but shining, without microsculpture, punctures finer and sparser at base; hind angles and sides (lateral to pit and ridge) smooth and finely punctured, without annular punctures; anterior border of pronotum lacking for 0.25-0.4× width of prothorax; base of lateral part of hypomeron without annular punctures; elytra relatively flat in profile; elytra shining, not microreticulate, intervals finely and sparsely punctured, not more obviously at sides; apical half of ventral surfaces of mid and hind femora with annular punctures and fine punctures.

Abdomen (Figs 1B, 7H). Pygidium: shining, not microreticulate, disc finely punctured to impunctate; last ventrite impunctate, without conspicuous annular punctures; internal margin of female pygidial apex shallowly excavate.

Male genitalia (Figs 2F, 4C-D, 6D-E). Apices of parameres strongly deflexed as a flat lobe with small basal convexity, rounded tubercle, sharp inwardly directed triangular tubercle, or curved spur; lateral sac of endophallus with median patch of fine stiff spines, around massive strongly sclerotised spine, 0.75-1 × width of sac; flagellum relatively curved; basal sclerite quadrangular, with strong median fold and basal lobes.

Female genitalia (Figs 8D, 9H-J, 10I-J). Dorsal sclerite flat and broad, without sharp transverse ridge; vulvar sclerite strongly asymmetric, produced above genital opening as a sharp quadrate lobe above deep oblique groove and beside broad folded cavity; spermatheca relatively small.

Intraspecific variation. There is variation in the shape of the paramere lobes (Figs 2F, 4C-E), including the angulation of the inner margin and the size of the tubercles. In the northern populations the parameres are almost identical to those of *C. nitida*, but in southern populations (Iron Range and McIlwraith Range) the tubercles are reduced to triangular points, small bumps, or are absent, as noted by Matthews (1976). The vulvar sclerite also varies (Figs 8D, 9H-J), but consistently has a large sharp quadrate lobe above a deep oblique groove, beside a broad shallow pouch. There appear to be no consistent differences, between northern and southern populations, in either the endophallus (Fig. 6D-E) or female genitalia.

REMARKS. Harold's type material (in MCG, not Museum of Natural History, Paris (Matthews, 1976; Cassis & Weir 1992)) has been examined and a male and a female paralectotype dissected to fix the identity of this species (Figs 4D, 9H). The shape of the parameres is variable and the apices (usually diagnostic in *Coptodactyla*) may be almost identical to those of the allopatric *C. storeyi*, but the structures of the endophallus and vulvar plate are consistently different.

Coptodactyla subaenea is the only member of the complex known from the northern tip of Cape York Peninsula, but is sympatric with *C. matthewsi* to the south, in the Iron and McIllwraith Ranges, where the two species occasionally occur together (Fig. 11). It has been collected from human and dingo dung, rotting bananas and fungi, yellow pan traps, flight traps and at light. It occurs commonly in a range of habitats, including scrub heath, open forest and rainforest, from 0 to 520m above sea-level. Specimens have been collected in every month from November (once) to July, except June.

DISCUSSION

Six species are discriminated here from 1,750 specimens of *Coptodactyla*, which had been confused under the names *C. papua* and *C. subaenea*. External characters allow identification of three taxa: the *C. merdeka*/*C. papua* pair, *C. matthewsi* and the complex of *C. nitida*/*C. storeyi*/*C. subaenea*. The structure of the parameres (Figs 2C-F, 3, 4) separates all species except *C. nitida*/*C. subaenea*, whereas the structure of the endophallus (Figs 5B-E, 6) separates all species except *C. nitida*/*C. storeyi*. The vulvar sclerites may be diagnostic for each species (Figs 8-9), but the difference between *C. merdeka* and *C. papua* is based on two specimens, and the difference between *C. nitida* and *C. storeyi* is slight. The spermatheca is almost identical in all species (Fig. 10). The traditional external and male genitalic characters fail to discriminate two species, *C. nitida* and *C. subaenea*, which are easily distinguished by the endophallus and vulvar sclerites.

PHYLOGENETIC ANALYSIS. The *subaenea* species-complex is a monophyletic group within *Coptodactyla*, defined by two synapomorphies: lack of complete anterior pronotal border and lack of male secondary sexual characters. A small set of cladistically varying, mostly primary sexual, characters (Table 1), was found for this species-complex and polarised by reference to all other species of *Coptodactyla* (all 0 states for Table 1). Parsimony analysis of this set produced three minimum-length trees with lack of resolution of the -(*nitida*, *storeyi*, *subaenea*) clade. This clade may be resolved on similarity criteria, as *C. nitida* and *C. storeyi* are almost indistinguishable in both male and female primary sexual characters, giving a single phylogenetic hypothesis (Fig. 13).

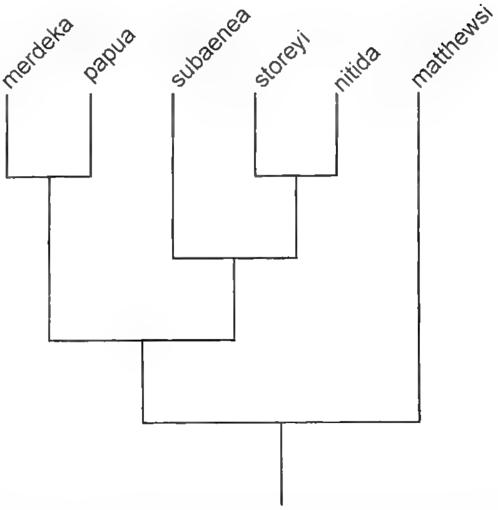

FIG. 13. Cladogram of *Coptodactyla subaenea* species-complex, based on characters listed in Table 1, polarised by comparison with other species of *Coptodactyla*.

BIOGEOGRAPHY. The two sister (or at least most similar) species, *C. nitida* and *C. storeyi*, are only separated by proportional differences in the parameres and vulvar sclerites. Nevertheless, separation of the specimens using these characters shows two adjacent allopatric distributions in the Wet Tropics of north Queensland, with the boundary approximately between Mareeba and Atherton (Fig. 12). This boundary is at the southern edge of the Black Mountain Barrier (BMB), a well known region of population disjunction in vertebrates (Joseph et al. 1995; Schneider et al. 1998). The BMB was a broad swathe of low-rainfall woodland at various periods of late Tertiary and Pleistocene maximum aridity, separating blocks of rainforest to north and south (Nix & Switzer 1991; Hopkins et al. 1996) and a likely precursor to speciation in rainforest taxa. In the *C. nitida*/*storeyi* species pair, soil moisture is probably as much a limiting factor as forest type, as both occur in a broad range of the latter, including open woodland, but are only active in the wetter months of the year. For these species, at times of high aridity, the low rainfall of the BMB provided a soil barrier together with probable absence of closed forest. The coincidence of the distributions of the weakly discriminated *C. nitida* and *C. storeyi* with a known historical geographic barrier supports recognition of these taxa as species. No males with intermediate genitalia have been seen, but there are two indeterminate female specimens, both from the north-west slopes of the Lamb Range (Clohesy River and Davies Creek), at the junction of the two species.

At present, it is not known what maintains the narrow boundary of the species *C. nitida* and *C. storeyi*, although it does not appear to be edaphic factors as both species occupy similar climatic space (Reid et al., in press). The relative lack of variation in paramere and vulvar sclerites in these species, compared with *C. subaenea*, may indicate that a significant part of species-discrimination occurs during attempted copulation. This may partly explain sympatry of *C. matthewsi* and *C. subaenea*, which are relatively phylogenetically distant and have the most divergent male and female genitalia.

KEY TO SPECIES OF *COPTODACTYLA* BURMEISTER

(modified from Matthews (1976); abbreviations used in key: NG = New Guinea; CQ, NQ, SQ = central, north and south Queensland; NT = Northern Territory)

1. Angular or arcuate ridge on underside of clypeal margin accompanied by a narrow groove for more than half width, median lobe of metasternum without anterior depression: both sexes without cephalic or pronotal armature . . . 2

Underside of clypeal margin with small transverse or round pit or this absent; median lobe of metasternum with shallow depression in middle of anterior; major male with horn on head and usually anterior pronotal folds 10

2(1). Pronotum with middle of anterior border effaced (Figs 1A, 2A-B); without sexual dimorphism of legs 3

Anterior pronotal border complete, except worn specimens of *C. depressa* Paulian, in which pronotum lacks basal row of sensory punctures and 8th and 9th striae do not reach elytral base; male femur with posterior marginal ridge interrupted at base 8

3(2). Annular punctures present at hind angles of pronotum and along lateral edges; each paramere with long thin spur at middle of apical lobe, overlapping other paramere or almost so (Fig. 3B,E); apex of female pygidium deeply excavate, lobes externally directed (Fig. 7D-E) (lateral lobe of endophallus with minute apical spine or spine absent (Figs 5C, 6A); vulvar sclerite almost symmetrical, without sharp lobe (Figs 9B,E)) (NG) 4

Hind angles of pronotum and basal half of lateral margins smooth, almost impunctate, without annular punctures (rarely 1-3 present) (Fig. 1A); each paramere with thick slightly incurved spine at base of apical lobe (Fig. 2D-F), or apical lobes straight and elongate (Fig. 2C); if apex of female pygidium deeply excavate, lobes internally directed (NQ) 5

4(3). Sides of parameres deeply hollowed, bounded by sharp longitudinal ridge (Fig. 3D), apical spurs of parameres produced; lateral lobe of endophallus without sclerite (Fig. 6A); ridge of vulvar sclerite less strong, angular (Fig. 9E) . . . . *papua* Lansberge

Sides of parameres not deeply hollowed, without longitudinal ridge (Fig. 3B), apical spurs tightly overlapping lobes; lateral lobe of endophallus with minute sclerite (Fig. 5C); vulvar sclerite more strongly ridged, convex (Fig. 9B) . . . . *merdeka* sp. nov.

5(3) Genal angles finely punctured, almost impunctate, smooth (Fig. 2A); elytral disc densely microreticulate, contrasting with shining suture and lateral intervals; parameres with straight elongate apical lobes, without incurved spines (Figs 2C, 3A); lateral lobe of endophallus without apical spine (Figs 5B); apex of female pygidium (Fig. 7C) deeply excavate, lobes internally directed; vulvar sclerite almost symmetrical, without sharp lobe (Figs 8A, 9A) (Iron & McIlwraith Ranges). . . . . *matthewsi* sp. nov.

Genal angles strongly punctured, transversely rugose, as anterior of frontoclypeus but less wrinkled (Fig. 2B); elytra not microreticulate (old specimens may be densely scratched and dull): apical lobes of parameres usually with incurved basal spines (spines may be reduced to small tubercles: Figs 2D-F, 4C-E); endophallus with prominent spine (Fig. 6B-E): apex of female pygidium shallowly excavate (Fig. 7F-H); vulvar sclerite with asymmetric sharp lobe (Fig. 8B-D) 6

6(4). Apex of parameres with short triangular or blunt tubercle, or without tubercle, at base of apical lobe (Figs 2F, 4C-E); lateral lobe of endophallus with massive apical spine, 0.75-1 × width of sac (Fig. 6D-F); vulvar sclerite with large sharp lobe, quadrate in shape (Figs 8D, 9H-J) (tip of Cape York Peninsula south to Iron & McIlwraith Ranges) . . . . *subaenea* Harold

Apex of parameres with larger sharply pointed basal spur (Fig. 2D-E); endophallus with smaller spine, 0.3-0.5 × width of sac (Figs 5D-E, 6B-C); vulvar sclerite with smaller triangular or rounded lobe (Fig. 8B-C) 7

7(6). Apical lobe of parameres with large down-curved spurs (Figs 2E, 4A-B, 12); vulvar sclerite with triangular sharper lobe (Figs 8C, 9F-G) (Cape Flattery south to Cairns and Mareeba) . . . . *storeyi* sp. nov.

Apex of paramere with short incurved spur at base of lobe (Figs 2D, 3C-D, 12); lobe of vulvar sclerite more rounded in profile (Figs 8B, 9C-D) (Mareeba south to Paluma) . . . . *nitida* Paulian

8(2). 8th and 9th elytral striae effaced at base, 9th for at least basal quarter; male without spur on fore tibia; elytral striae impunctate and elytra without pseudepipleura (NQ) . . . . *depressa* Paulian

8th and 9th striae complete or almost so; male with median spur on fore tibia 9

9(8). 9th elytral interval evenly rounded; elytral striae strongly punctate; lateral carina of pronotum, from margin to lateral depression, sharp (SQ) . . . . *meridionalis* Matthews

9th elytral interval strongly recurved, at least for apical 3/4, forming pseudepipleuron; elytral striae impunctate or almost so; lateral carina of pronotum obsolete (C&NQ) . . . . *onitoides* Gillet

10(1). Ridge on underside of clypeus without pit; femora impunctate; length 15-18mm & striae impunctate (NQ) . . . . *ducalis* Blackburn

Ridge with pit; femora with a few punctures; if length >14mm striae punctate 11

11(10). Lateral carina of pronotum completely sharp; striae with large punctures with raised centres 12

Lateral carina of pronotum effaced before fossa; striae impunctate or finely punctured. 14

12(11). Basal fifth of 8th stria missing; anterior of pronotal disc impunctate; male without pronotal tubercles or folds (NQ, NT) . . . . *glabricollis* (Hope)

8th stria complete or almost so; female with anterior of pronotal disc closely punctate; male with pronotal tubercles or folds 13

13(12). Ridge on underside of clypeus with transverse groove; major male with simple anterior pronotal excavation (NT) . . . . *lesnei* Paulian

Ridge with minute pit; major male with row of transverse wrinkles at sides of anterior pronotal excavation (NT) . . . . *stereocera* Gillet

14(11). Elytral striae complete to base; female with 2 faint depressions on anterior of pronotal disc; major male with pair of blunt tubercles at top of anterior pronotal excavation and tip of cephalic horn not expanded or secondarily lobed (NQ) . . . . *brooksi* Matthews

8th stria effaced before base; female without depressions; major male with tip of cephalic horn expanded or secondarily lobed 15

15(14). Major male: cephalic horn long and narrow and secondarily lobed at tip; pronotal median groove present 16

Major male: cephalic horn short and broad, with flat explanate tip; pronotal tubercles single, widely separated and without groove between (NQ) . *torresica* Matthews

16(15). Major male: cephalic horn long & narrow, with concave quadrituberculate tip, anterior and basal tubercles more strongly raised, but all small and evenly convex; tubercles above anterior pronotal excavation bifid with deep hollow between (NQ) . . . . *monstrosa* Felsche

Major male: frontoclypeal horn long & narrow, with bituberculate apex, anterior tubercle small and hollowed, posterior broad and bidentate at tip; pronotal anterior with two transverse depressions, subcarinate above these and with shallow median groove (NG) . . . . *tuberculata* Gillet

ACKNOWLEDGEMENTS

This paper would have been much poorer without the achievements of the main collectors, Geoff Monteith, Ross Storey and Tom Weir, whose efforts are much appreciated. It was also dependent on a team of databasers, responsible for making all the label data available. I am grateful to the curators of the institutions from which specimens were borrowed: Martin Brendell (BMNH), François Génier (CMN), Geoff Monteith (QM), Roberto Poggi (MCG), Yayuk Soehardjono (MZB), Ross Storey (QDPIM). Ian Reid (no relation) and Eric Hines (CSIRO Entomology) helped considerably with the illustrations. Thanks to Pete Cranston and Craig Moritz for encouragement. This research was funded by the Co-operative Research Centre for Tropical Rainforest Ecology and Management. Geoff Thompson (QM) prepared the maps.

TABLE 1. Characters used for cladistic analysis of *Coptodactyla subaenea* species-complex.

1. Front margin pronotum. ***0.*** complete. ***1.*** medially absent.

2. Annular punctures. ***0.*** absent from lateral pronotal margins. ***1.*** present throughout.

3. Males. ***0.*** with secondary sexual modifications. ***1.*** without.

4. Tips of parameres. ***0.*** deflected, without median tubercles or spurs. ***1.*** with basal tubercles or short thickened median spurs. ***2.*** apical thin elongate spurs.

5. Parameres. ***0.*** not laterally keeled. ***1.*** at least keeled at base of deflexed apical lobes.

6. Endophallic lateral sac. ***0.*** without prominent triangular spine. ***1.*** with.

7. Endophallic basal sclerite. ***0.*** with lateral lobes and several folds. ***1.*** with single median fold.

8. Internal lobes apical margin female pygidium. ***0.*** prominent. ***1.*** reduced.

9. Vulvar sclerite. ***0.*** symmetrical. ***1.*** strongly asymmetric with prominent lobe.

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REVISION OF THE DUNG BEETLE GENUS *TEMNOPLECTRON* WESTWOOD (COLEOPTERA: SCARABAEIDAE: SCARABAEINI)

C.A.M. REID AND R.I. STOREY

Reid, C.A.M. & Storey, R.I. 2000 12 31: Revision of the dung beetle genus *Temnoplectron* Westwood (Coleoptera: Scarabaeidae: Scarabaeini). *Memoirs of the Queensland Museum* **46**(1): 253-297. Brisbane. ISSN 0079-8835.

Temnoplectron Westwood is revised and five new species described, four from North Queensland: *cooki*, *finnigani*, *lewisense*, *monteithi*, one from New Guinea: *wareo*. *Temnoplectron reyi* Paulian is removed from synonymy with *T. politulum* Macleay, *Temnoplectron laevigatum* Matthews is placed in synonymy with *T. boucomonti* Paulian, *T. heurni* Paulian and *T. howdeni* Paulian are synonymised with *T. atropolitum* Gillet, and *T. major* Paulian is recognised in Australia for the first time. All known species are redescribed. A key is provided for the 19 species of *Temnoplectron* and new distribution records are noted. A cladistic analysis of the genus is presented, the results of which suggest at least two origins for flightlessness in the genus. The biogeography of *Temnoplectron* is discussed with reference to isolation of rainforest blocks during periods of maximum aridity. ❒ *Coleoptera, Scarabaeidae, Temnoplectron, Australia, New Guinea.*

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The scarabaeine fauna of Australia is one of the best known speciose beetle groups on this continent, thanks to taxonomic revisions of all the genera by Matthews (1972, 1974, 1976). These works were partly based on surveys of pastoral country prior to the introduction of exotic species (Bornemissza, 1976) and collections by Matthews himself. The rainforests of north Queensland were relatively under-explored for scarabaeines until systematic collecting by Ross Storey, Geoff Monteith (Queensland Museum) and others, from 1976. Some material from these collections has been described (Storey, 1977, 1984, 1986, 1991; Matthews & Stebnicka, 1986; Storey & Weir, 1990; Storey & Monteith, 2000; Reid, 2000), but many new species remain undescribed, especially in the larger genera.

Temnoplectron Westwood is a genus of Scarabaeini with 16 described species prior to this revision; 10 in Australia (Matthews, 1974) and 6 in New Guinea (Paulian, 1985). The genus is well-defined and probably monophyletic, although it is possible that *Temnoplectron* is paraphyletic with respect to *Monoplistes* Lansberge and *Diorygopyx* Matthews (Matthews, 1974). The last two appear to be sister-taxa. The current revision is concerned with attaching names to species, preparatory to forthcoming phylogenetic analysis of the Australian Scarabaeini, which may result in changes to the generic concepts. More than 7,500 Australian specimens of *Temnoplectron* have been examined, collected from all of the major rainforest blocks in north Queensland. This recent collecting has discovered four new flightless montane species and several cryptic-species complexes, which are described here. Nineteen species are now recognised in the genus, 16 in Australia and 5 in New Guinea. A key to the species is presented.

The species of *Temnoplectron* are confined to the tropics and subtropics, as far south as the Brisbane area. The feeding and nidal behaviour of *Temnoplectron laevigatum* Matthews was described by Matthews (1974), and the biology of *T. involucre* Matthews has been examined in detail by Agnes Rortais, James Cook University, Townsville (1999, unpubl. PhD). To this can be added published studies of altitudinal range (Monteith, 1985), perching (Howden, Howden & Storey, 1991), seasonality in two species (Hill, 1993), edge effects (Hill, 1995), habitat fidelity, diel activity and diet (Hill, 1996). These studies show that, for the commoner species in the southern part of the Wet Tropics, collecting *Temnoplectron* is best within rainforest, between December and April, at night, using dung baits. *Temnoplectron* species are also attracted to liver, mushroom and banana baits (Hill, 1996). Other species occur in open woodland or dry forest (Matthews, 1974).

MATERIALS AND METHODS

MORPHOLOGY. The morphology of *Temnoplectron* was studied in detail to obtain as many characters as possible for phylogenetic analysis. Most terms for external characters should be obvious or self explanatory. The microsculpture is described as seen under 50× magnification. Several ratios are used in the descriptions as convenient short-hand descriptors of attributes, but it should be noted that many specimens are asymmetric and therefore the ratios can vary for a single specimen. The eye width is the width of the dorsal part of the eye at its widest point, which may be basal or medial, and is compared with the shortest dorsal distance between the eyes to give the interocular ratio. The hypomeral stria is the ridge and groove from the base of the hypomeron, parallel to the lateral margin (Fig. 4); it is compared with the length of the hypomeron to the posterior edge of the femoral excavation, at that point, to give the hypomeral ratio. The subtle greenish colour of the elytra is best seen by comparison with the pronotum (always black), under strong lighting. Striae 8-10 do not reach the basal edge of the elytra but are always abbreviated by short distances which are useful for diagnosing species. These distances are most conveniently measured against the length of the mesepimeron, where it touches the epipleuron. The outer margin of the fore tibia has three large major teeth, and an indeterminate number of minor teeth (Fig. 7). The length of the male hind tibial spine (Fig. 14) is often diagnostic (in fresh specimens) and is best compared with the width of the tibia at the base of the spine, which gives the tibial spine ratio.

Male genitalia were prepared by immersion in dilute KOH for several hours then rinsing in water. The endophallus was removed by cutting the membrane between the parameres and basal piece and separating these. In all species it is a simple tube without lateral lobes. The endophallus was pulled apart to expose the sclerites. A nomenclature of male endophallic sclerites in Coprini was provided by Génier (1996), which was modified for *Coptodactyla* Burmeister (Reid, 2000) and this system is appropriate for *Temnoplectron* species. In the latter, there are 4 endophallic sclerites (Fig. 20, flagellum omitted), in a single ejaculatory sac, which form the sperm pump when everted: the flagellum, almost uniformly shaped, with broad, trilobed and ridged base and single whip-like apex; the basal sclerite, an irregular folded plate or almost solid sclerotised lump adjacent to the flagellum; the ring sclerite, a sclerotised ring at or beyond the tip of the flagellum; the median sclerite, a deeply folded irregular shape in the middle of the endophallus. Other areas of sclerotisation may be present, but when observed through the inverted wall are poorly defined and generally only lightly sclerotised. The flagellum, being almost invariable, is not illustrated, the other sclerites are illustrated for almost all species.

Female genitalia were removed by tearing the softened integument along one side of the abdominal tergum and around the margins of the abdominal apex, freeing the genitalia plus gut from the abdominal walls. This unit was softened in dilute KOH, then water, and cleaned with removal of most of the gut, tracheae and glandular tissue. The spermatheca was examined in glycerol. The female genitalic system of *Temnoplectron* is unusual amongst Scarabaeinae in having the spermathecal duct opening directly to the external surface of the animal, not via the vagina, which is a separate ventrally situated duct (Fig. 23). There is often secondary sclerotisation around the entrance of the spermathecal duct, which may form a transverse or quadrate bar, the spermathecal sclerite. The characteristic sclerite between the female genitalia and the anus of *Coptodactyla* (Reid, in press) is absent, and the hemisternites are small and insignificant short quadrangular struts, internally placed on either side of the anus. The spermatheca, in common with many Scarabaeinae, has a transparent semi-circular window at the middle, on the inside margin of the point of inflexion (Fig. 24). The spermatheca showed little variation and is therefore not illustrated for all species, but the spermathecal sclerite, if present, is illustrated.

Descriptions are based on freshly emerged specimens, if available. Older specimens may have scratched dorsal surfaces, eroded fore tibial teeth (compare Figs 7G & H), tibial spurs, and hind tibial spines (compare Figs 15A & B), and the frontoclypeus may be blunted.

MATERIAL. Abbreviations for repositories are as follows: Australian Museum, Sydney (AMS); Australian National Insect Collection, Canberra (ANIC); Canadian Museum for Nature, Ottawa (CMN); Deutsches Entomologische Institut, Berlin (DEB); Hope Department of Entomology, Oxford (HDO); James Cook University, Townsville and Cairns campuses (JCU); Museo Civici, Genoa (MCG); Museum Zoologicum Bogoriense, Bogor, Indonesia (MZB); Natural

History Museum, Paris (MNHN); National Museum, Prague (NMP); Queensland Department of Primary Industry, Mareeba (DPIM); Queensland Museum, Brisbane (QM); South Australian Museum, Adelaide (SAM); University of Queensland Insect Collection, Brisbane (UQ), Western Australian Museum, Perth (WAM)

Abbreviations for collector's names (with more than two entries) are as follows: CB, C. Burwell; GB, G. Bornemissza; EB, E.B. Britton; JGB, J.G. Brooks; JDB, J.D. Brown; IC, I.F.B. Common; DC, D.J. Cook; DIC, D.J. & I. Cook; JD, J.T. Doyen; EE, E.D. Edwards; JF, J. Feehan; PF, P. Ferrar; GH, G.A. Holloway; HAH, H. & A. Howden; RH, R. Huppatz; HJ, H. Janetzki; EM, E.G. Matthews; DM, D.K. McAlpine; SM, S. Misko; GM, G.B. Monteith; GSM, G.B. & S.R. Monteith; MBM, M.S. & B.J. Moulds; SJP, S. & J. Peck; CR, C.A.M. Reid; IR, I. Reid; DR, D.C.F. Rentz; LR, L. Roberts; JS, J. Seymour; RS, R.I. Storey; RT, R.W. Taylor; GT, G.I. Thompson; MU, M.S. Upton; AWH, A. Walford-Huggins; AMWH, A. & M. Walford-Huggins; JW, J.L. Wassell; TW, T.A. Weir; DY, D.K. Yeates; PZ, P. Zborowski.

Abbreviations for geographic features: Bch, Beach; C, Cape; Ck, Creek; I., Island; Mt, Mount/Mountain; NP, National Park; Pt, Point; Ra, Range; R, River; Rd, Road; SF, State Forest; Tbld, Tableland.

DEFINITIONS OF SPECIES. A species is usually designated such by a taxonomist in ignorance of the full range of variation of the organism concerned. This morphological study, based on more than 7,800 specimens, has allowed a reasonable understanding of intra- and inter-population variation within species. Even the rarest Australian species is represented by 80 specimens.

Some of the new taxonomic decisions given here are the result of discovery of hitherto unknown morphotypes, or of cryptic species with distinctive male genitalia. These species are fairly obvious. However, *Temnoplectron* has a particularly difficult species-complex which was only partly resolved in the last revision (Matthews, 1974): the *rotundum* species-group. In this group, surface sculpture varies, perhaps clinally, so that fresh specimens from range extremes may have quite different punctation and microsculpture. This issue is further confused by the high frequency of old abraded specimens, as in species of *Coptodactyla* Burmeister (Matthews, 1976; Reid, 2000). As a rough guide to partitioning species in the *rotundum*-group we first relied on male secondary sexual characters on fresh major male specimens, arguing that these are important in mate-recognition and therefore species-discrimination by the organisms. We believe this is likely because in the *rotundum* species-group the primary male sexual organ, the aedeagus, shows little variation, whereas in the other species of *Temnoplectron* there is little or no development of secondary sexual characters but large and constant differences in aedeagal morphology (for example in the *politulum* species-complex, Fig. 19G, H). From this starting point, it became obvious that characters of the surface sculpture and elytral striae are too variable in the *rotundum* species-group to be used diagnostically, although these may be valuable characters in the other species-groups. On the other hand, there are excellent male leg characters which are diagnostic for each species. The results of our study of the *rotundum* species-group are some new synonymy and the recognition of a new species for the Australian fauna.

We have used the family name Laporte in place of Castelnau for the author of *Temnoplectron laeve*. Castelnau is an honorific title, for François Louis Nompar de Caumont Laporte, self-styled Compte de Castelnau (Musgrave, 1932).

Temnoplectron Westwood, 1841

TYPE SPECIES. *Temnoplectron rotundum* Westwood, by monotypy (Matthews, 1974).

DISTRIBUTION. Australia, from near Brisbane north and west to Cape York and the Kimberley Ranges, and New Guinea.

DIAGNOSIS. The genus was comprehensively described by Matthews (1974). Amongst Australian Canthonini it is identified by the following attributes: elytron without pseudepipleuron outside stria 7; each claw with sharp basal tooth; mid and hind tibial spurs not fused to tibial apex; pygidium without basal groove or depression.

A few minor additions or alterations need be made to the features listed by Matthews (1974): hypomeral stria present (minute in some specimens of *T. diversicolle* Blackburn); elytron with stria 8 present or absent; fore tibia of male not internally lobed at apex, with 3 large outer teeth and many small subsidiary teeth; mid tibia with two articulated spurs; hind tibia with prolongation (spine) present or absent; articulated spur present or absent; first hind tarsal segment as long as or shorter than second; parameres symmetrical or asymmetric, apices not strongly deflexed ventrally; endophallus with four sclerites; female with entry to spermathecal duct externally exposed on ridge (often sclerotised) between vagina and anus; spermathecal duct long and tightly coiled.

The male can be distinguished by: apical fore tibial spur broader, ovate and bladelike (compare Fig. 9 parts E & F); pygidium longer; last ventrite medially foreshortened. Secondary sexual modifications may be present on the male pronotum, mid and hind femora and hind tibia. Most males have extended hind tibial spines in contrast to the unspined females (compare Fig. 13 parts E & F or 15B & C). Four species show sexual dimorphism in elytral surface sculpture.

The larval and pupal morphology is undescribed.

KEY TO SPECIES OF *TEMNOPLECTRON* WESTWOOD

Supplementary character states for a half couplet are given in brackets. Note that both states of couplet 12 are present in *T. cooki*, *T. lewisense* and *T. monteithi*. The couplets may appear cumbersome but appear to work for the thousands of specimens we have seen, including dwarf, deformed and teneral specimens.

1. Last two ventrites (5 and 6) separated by deep groove with row of large punctures (annular pits); head and pronotum impunctate, or extremely finely punctured (fronto-clypeal margin not produced between genal angle and median teeth; macropterous; ♂ posterior tibial spine short, flat and triangular, less than apical width of tibia, without spur; hind tarsi long, 0.35-0.5 length hind tibia; length 8-10mm; NG) . . . . *atropolitum* Gillet

Suture between last two ventrites not or weakly grooved, without row of punctures; head, and usually also pronotum, distinctly punctured 2

2(1). Larger, length 8-13mm; basal segment of labial palp much wider and 1.3-2 × longer than 2nd segment (eyes large, interocular ratio 4-7; lateral margins of pronotum complete; macropterous; 8th elytral stria present; ♂ posterior tibial spine elongate, as long as or longer than tibial width; hind tarsi short, <0.3 × length hind tibia; base of metasternal process without triangularly expanded margins) (*rotundum* species-complex). . . 3

Smaller, length 3.5-7.5mm; basal segment of labial palpi as wide as and 1-1.5 × longer than 2nd segment (margins of frontoclypeus not rugosely punctured and not, or feebly, produced beside median teeth; ♂ mid femur not modified; ♂ hind tibia with articulated spur) 7

3(2). Clypeal margin almost straight between genal angles and median teeth, not expanded (Fig. 2A); basal margin of ♂ pygidium medially swollen (Fig. 16B); apex of ♂ hind tibia with small articulated spur (Fig. 14A) (hypomeral ratio 0.3-0.6; 1-2 minor teeth between major teeth of fore tibia; ♂ pronotum not medially depressed; 8th stria almost reaching base of elytra, abbreviated at base by ≤ length of mesepimeron; ♂ mid and hind femora broadest in apical half; ♂ hind tibial spine ratio 1.5-2, spine thick and blunt). 4

Clypeal margin curved between genal angles and median teeth, convex near median teeth (Fig. 2B) (less obvious in worn specimens); ♂ pygidium with straight or evenly curved basal margin (Fig. 16A); apex of ♂ hind tibia without articulated spur (Fig. 14B) (if hypomeral ratio <0.6, 1-4 minor teeth between major teeth of fore tibia) 5

4(3). Frontoclypeus surface entirely finely punctate, or slightly rugose at anterior margins; venter of ♂ and ♀ mid femora evenly curved, not lobed or expanded at apex (Fig. 11A); parameres more elongate, almost symmetrical (Fig. 17A-B) (NQ) . . *bornemisszai* Matthews

Frontoclypeus more strongly punctate and rugose towards the edges; ♂ mid femur with strong preapical ventral lobe (Fig. 11E), venter of ♀ mid femur slightly preapically expanded; parameres shorter, left thicker and less pointed than right (Fig. 17E) (NQ) . . *laeve* Laporte

5(3). Outer margin of fore tibia with 1-2 minor teeth between major teeth (Fig. 7B-D); inner margin fore tibia not emarginate; ♂ mid femur relatively flat, broadest in apical half, with large preapical ventral lobe and ♀ mid femur slightly ventrally expanded in apical half (Fig. 11B); ♂ hind femur broadest in apical half, ventrally narrowed at apex (Fig. 11H); ♂ hind tibial spine ratio 1.5-2, spine gradually tapered in profile (Fig. 14B-D); ♂ pronotum not antero-medially depressed (parameres asymmetric, left blunt, right narrower with sharp flat apical lobe) (S, C & NQ, NT, WA, NG). . . . . *boucomonti* Paulian

Outer margin of fore tibia with 2-4 minor teeth between major teeth (Fig. 7E-H); inner margin fore tibia usually distinctly emarginate in basal half; ♂ and ♀ mid femora not expanded in apical half, broadest at middle (Fig. 11C-D); ♂ hind femur broadest in middle or in basal half (Fig. 11F, J); apical spine ♂ hind tibia long and thick, or short and flat; ♂ pronotum often antero-medially depressed 6

6(5). Outer face of hind tibia evenly contracted to base (Fig. 12B); inner margin of fore tibia emarginate about 0.3-0.4 length from base (Fig. 7E-F); hypomeral ratio 0.4-0.7; 8th elytral stria abbreviated by 0.5-1.5 × length of mesepimeron; pronotum and elytra dull, strongly and evenly microreticulate (except pronotal disc shining and not microreticulate in some Cape York Peninsula specimens); major ♂ pronotum deeply antero-medially depressed with lateral tubercles; ♂ mid femur without swollen external face; ♂ hind femur broadest at middle, evenly tapered to apex (also ♀) (Fig. 11J); apical spine of ♂ hind tibia massive and blunt, almost as thick as broad (Fig. 14F-G); parameres strongly asymmetric, left strongly curved, blunt, right with large flat apical lobe (Fig. 17G-H) (NQ & NG) . . . . *major* Paulian

Outer face of hind tibia abruptly contracted at base (Fig. 12C); inner margin of fore tibia emarginate 0.2-0.25 length from base (emargination rarely absent in ♀) (Fig. 7G-H); hypomeral ratio 0.6-0.9; 8th elytral stria abbreviated by 1-3 × length mesepimeron; disc of pronotum shining, not or shallowly microreticulate, in contrast to dull elytra; major ♂ pronotum shallowly depressed without lateral tubercles; ♂ mid femur broadest at middle, outer face swollen (less so in minor ♂); ♂ hind femur broadest before middle, with apex ventrally lobed (slightly so in ♀) (Fig. 11F); apical spine of ♂ hind tibia short, equal to apical tibial width, and flat in profile (Fig. 14H-I); parameres asymmetric, left thick and blunt, right with short flat lobe at apex (Fig. 17I-J) (NT, NQ) . . . . *rotundum* Westwood

7(2). Basal quarter of elytra with 10 striae, 8th abbreviated by <2 × length mesepimeron, usually reaching apical half of elytra (eyes large, interocular ratio 3.5-4.5; pronotum shining, disc not or shallowly microreticulate, strongly punctured and lateral margin complete; elytra dark bronze-green; macropterous or almost so, wings extend beyond abdominal apex; ♂ hind tibial spine ratio 0.75-1.25; length 4-6.5mm). 8

Basal quarter of elytra with at most 9 striae, 8th abbreviated by >3 × length mesepimeron, usually confined to second quarter of elytra (*T. diversicolle*, *T. finnigani*, some *T. cooki*), or reduced to a few elongate punctures, or absent. 9

8(7). Right paramere without preapical dorsal notch in lateral view (Fig. 19B) (length 5-6.5mm; head strongly but sparsely punctured, dull and strongly microreticulate; ♂ elytra entirely dull and microreticulate, ♀ with intervals 5-10 or 6-10 shining, not obviously microsculptured except at extreme base; striae 1-7 with obvious foveolate punctures in apical half of elytra; fore tibia with 3-7 sharp minor teeth between major teeth) (NQ) . . . . *aeneopiceum* Matthews

Right paramere with preapical dorsal notch (Fig. 19C) (length 4-5.5mm (5-5.5mm on Carbine Tbld); punctures and microsculpture of head usually uneven in density and size, with part (at least patch anterior to eye) or all of head shining; basal third to half of ♂ elytra shining and without microsculpture, apex microreticulate, ♀ with elytra entirely shining or only microreticulate on apical half of intervals 1-4; striae 1-7 not, indistinctly, or rarely distinctly, punctate in apical third; fore tibia with 2-5 minor, usually blunt, teeth between major teeth) (NQ) . . . . *subvolitans* Matthews

9(7). Basal border of pygidium with middle strongly produced (Fig. 16D) (elytra dark bronze-green; lateral pronotal border complete; brachypterous, wing scale half elytral length; 8th stria present as impressed line on second quarter of elytra; interocular ratio 7-8.5; ♂ hind tibial spine ratio 0.65-0.75, spine blunt; parameres symmetrical, each with preapical fringe of long hairs) (NQ) . . . . *finnigani* sp. nov.

Basal border of pygidium not medially produced, but straight or evenly curved (fig. 16C); without the above combination of characters 10

10(9). Lateral margin of pronotum partially or entirely effaced (Figs 4A-B,E,H) (anterior corners of metasternal process triangularly expanded) 11

Lateral margin of pronotum complete (Fig. 4C-D, F-G) (NQ) 17

11(10). Lateral margin of pronotum missing medially, at least present in apical and basal fifths, usually only effaced in middle quarter (Fig. 4E, H); brachypterous or wingless (Fig. 5D); eyes small, interocular ratio 8-12 (Fig. 3P-Q) (meso-metasternal margin with small triangular excision; NQ) 12

Lateral margin completely effaced, or only present in corners (Fig. 4A-B); macropterous; eyes larger, interocular ratio 3-6.5 (Fig. 3A-B) (length 4.5-5.5mm) . . 15

12(11). Size larger, length 5.5-7.5mm; ♂ hind tibia with long apical spine, equal to width of tibia (Fig. 15E-G) (linear segment of 8th stria usually partially present in second quarter of elytra) 13

Size smaller, length 3.5-4.5mm; ♂ hind tibia with short apical spine, less than half apical width of tibia (Fig. 13N-O) (8th stria absent or reduced to 2-3 punctures; pronotum strongly punctured, sides of disc with some interspaces equal to puncture diameters; elytra green) 14

13(12). Eyes smaller, interocular ratio 11-12 (Fig. 3P-Q); body less elongate, and more convex (Fig. 1B), length:width ratio 1.25-1.45; remnant of 8th stria shorter, present as short groove in elytral second quarter or reduced to punctures (Fig. 4H); elytra black (length 5.5-7.5mm) . . . . *cooki* sp. nov.

Eyes larger, interocular ratio 8-9 (Fig. 3F); body more elongate, less convex (Fig. 1C), length:width ratio 1.40-1.65; 8th stria longer, at least throughout second quarter (Fig. 4E); elytra dark bronze-green (length 6-6.5mm). . . . . *diversicolle* Blackburn

14(12). Stria 9 deeply impressed, like stria 10, delineated by fine ridge, with at most 3-5 foveolate punctures in apical fifth; fore tibia with shorter, broader major teeth, separated by 3-5 convex or sharp minor teeth (Fig. 10F-H); base of upper epipleural margin not depressed; apices of both parameres concave, laterally depressed (Fig. 18E); apical spur of ♀ fore tibia evenly attenuated to curved tip (Fig. 10H) . . . . *lewisense* sp. nov.

Stria 9 shallow, much shallower than stria 10 and not delineated by a ridge, with scattered foveolate punctures throughout; fore tibia with longer, narrower major teeth, separated by 2-3 feebly convex or flat minor teeth (Fig. 10B-E); base of upper epipleural margin depressed; apex of left paramere bluntly rounded, apex of right paramere triangularly produced (Fig. 18C-D); apical spur of ♀ fore tibia angulate on inner margin (Fig. 10C-E) . . . . *monteithi* sp. nov.

15(11). Stria 1 strongly deepened in apical quarter of elytra; eyes larger, interocular ratio 3-4.5 (Fig. 3A-B); frontoclypeus slightly concave beside median teeth; ♂ hind tibia evenly curved, tibial spine ratio 0.6-0.75 (Fig. 13A-B); parameres symmetrical, with apico-ventral tooth (Fig. 19I-J) (NG). 16

Stria 1 not deepened at elytral apex; eyes smaller, interocular ratio 5.2-6.5 (Fig. 3C); frontoclypeus not concave beside median teeth; ♂ hind tibia slightly bent 0.25 from apex, tibial spine ratio 0.75-1.25 (Fig. 13C); parameres not symmetrical, without ventral tooth (Fig. 19E) (middle of pronotal disc finely and sparsely punctured; apex of elytra not produced; NQ) . . . . *disruptum* Matthews

16(15). Elytra in profile evenly curved to apex of suture (Fig. 4A); frontoclypeus strongly punctured, including anterior to eyes; eyes smaller, more evenly narrowed anteriorly, interocular ratio 3.8-4.5 (Fig. 3A); pronotal disc more strongly and densely punctured . . . . *aeneolum* Lansberge

Elytra in profile produced and slightly raised at apex of suture (Fig. 4B) (intervals 1-3 with subapical depression); frontoclypeus finely and sparsely punctured, anterior to eyes impunctate or almost so; eyes larger, abruptly curved anteriorly, interocular ratio 3-3.5 (Fig. 3B); pronotal disc more finely and sparsely punctured . . . . *wareo* sp. nov.

17(10). Eyes larger, interocular ratio 3.5-4.5 (Fig. 3J-K); macropterous; hind body elongate, sides evenly tapering from prominent elytral humeri to almost truncate apex (Fig. 1F) (length 6-7.5mm; black; ♀ outer elytral intervals shining, contrasting with dull microreticulate inner intervals; ♂ hind tibial spine sharp, tibial spine ratio 0.85-1.25) 18

Eyes smaller, interocular ratio 7-12; hind wings vestigial; hind body broad and rounded, without prominent elytral humeri 19

18(17). Left paramere evenly attenuated to triangular tip (Fig. 19G); basal third of striae 5-6 very lightly impressed to almost invisible, less impressed than on second third of elytra, whole of stria 7 similar. . . . *politulum* Macleay

Left paramere sharply produced in profile, with flattened tip (Fig. 19H); basal two-thirds of striae 5-6 evenly impressed, stria 7 similar or more strongly impressed . . . . *reyi* Paulian

19(17). Length 3.5-5mm; elytra distinctly bronzed or greenish; meso-metasternal border with small median transverse tubercle; ♂ hind tibia with short apical spine, tibial spine ratio <0.5; ♀ elytra shining and evenly shallowly microsculptured; one or both parameres concave, rounded or pointed in profile 20

Length 5.5-7.5mm; dorsum pure black; meso-metasternal border with flat triangular excision (Fig. 6B); ♂ hind tibia with long apical spine, tibial spine ratio 1-1.25 (Fig. 15F-G); ♀ outer elytral intervals shining, shallowly microsculptured, contrasting with dull inner intervals; both parameres with blunt or truncate apices in profile (Fig. 19D-E) (disc metasternum strongly punctured, mesosternum almost impunctate; wings straplike) . . . . *cooki* sp. nov.

20(19). Stria 9 similar to stria 10, deeply impressed, delineated by a fine ridge, with at most 3-5 foveolate punctures in apical fifth; 2-5 sharp minor teeth present between major teeth of anterior border of fore tibia; base of upper epipleural margin not depressed; apical spur of ♀ fore tibia evenly attenuated to curved tip 21

Stria 9 shallow, much shallower than stria 10 and not delineated by a ridge, with scattered foveolate punctures throughout; fore tibia with longer, narrower major teeth, separated by 2-3 feebly convex minor teeth (Fig. 10B-E); base of upper epipleural margin depressed; apical spur of ♀ fore tibia angulate on inner margin (Fig. 10C-E) (apex of left paramere bluntly rounded, apex of right paramere triangularly produced; both parameres with short subapical row of setae) . . . . *monteithi* sp. nov.

21(20). Elytra dark bronze-green, only slightly contrasting with pronotum, basal third of intervals 1-3 shining and usually without microsculpture; hypomeral stria convergent with side margin; interocular ratio 7-8, eyes broadest at base of dorsal portion (Fig. 3L); ♂ hind tibial spur 1.5 × length first tarsal segment (Fig. 13M); head, pronotum and metasternal median lobe usually finely and sparsely punctured; left paramere sinuate, with rounded apex, right paramere with angulate basal projection, neither with ventral setae (Fig. 18B) . . . . *involucre* Matthews

Elytra brassy-green, contrasting strongly with black pronotum, strongly microreticulate throughout; hypomeral stria almost parallel to side margin; interocular ratio 8-10, eyes broadest near middle of dorsal portion (Fig. 3M); ♂ hind tibial spur as long as or shorter than first tarsal segment (Fig. 13N); head, pronotum and metasternal median lobe usually strongly and closely punctured; apices of both parameres concave, laterally depressed, with short ventral row of small setae (Fig. 18E). . . . . *lewisense* sp. nov.

Temnoplectron aeneolum Lansberge
(Figs 3A, 4A, 8A, 13A, 19J, 21E, 23L, 24D, 25)

Temnoplectron aeneolum Lansberge, 1885: 375; Paulian, 1934: 285; Paulian, 1985: 224.

TYPE. Not seen (in MCG). The species is recognisable from the redescription of the type material given by Paulian.

MATERIAL. (5) PAPUA NEW GUINEA: 5, 34mi E Port Moresby, Kokoda Trail, 2200', dung traps, 14-18.vii.1974, S. Peck (CMN, DPIM)

DESCRIPTION (male). *Colour.* Body black, appendages reddish-brown.

Length: 4.5-5.5mm.

Head (Fig. 3A). Strongly but sparsely punctured, anterior, genae and middle of frontoclypeus more finely punctured and microreticulate than base; eyes large, evenly narrowed anteriorly, interocular ratio 3.8-4.5; anterior margin frontoclypeus strongly upraised and curved anteriorly from rounded genal angles, but slightly excavate before narrow apical teeth; first segment of labial palpi 1.2-1.5 × length second segment.

Thorax (Figs 4A, 8A, 13A). Pronotum: shining, not microreticulate except extreme lateral margins; pronotal disc strongly and closely punctured, not medially depressed; lateral margin pronotum entirely effaced, or almost so, at least 75% absent; hypomeral stria weakly expressed, hypomeral ratio 0.25-0.3; elytra entirely microreticulate, but shallowly and irregularly in basal third; elytra strongly arched in profile, highest at middle; stria 1 deepened in apical half, with 0-2 punctures; stria 8 reduced to a few elongate punctures in second elytral quarter, stria 9 abbreviated by 1.5-2 × length mesepimeron; base of epipleuron not constricted; macropterous; meso-metasternal border slightly raised, with narrow transverse median tubercle; median lobe of metasternum shining, without microsculpture except at extreme apex, finely but closely punctured, with margins triangularly expanded in apical corners; outer margin fore tibia with 2-4 convex minor teeth between three acute major teeth, inner margin slightly concave; mid and hind femora elongate-ovate; hind tibia with short apical spine, tibial spine ratio 0.75, with prominent articulated spur; hind tarsi long, 0.4 × length hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19J, 21E). Suture between last two ventrites simple, not deeply grooved and punctured; basal margin of pygidium evenly curved, without prominence in middle; parameres almost symmetrical, short and broad with triangular tooth on venter of apices, which are reflexed and overlapping, without fringe of

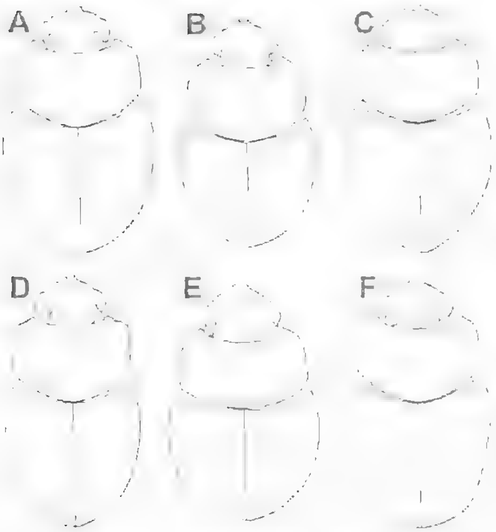

FIG. 1. *Temnoplectron* species, body outline: A, *boucomonti* Paulian; B, *cooki* sp. nov.; C, *diversicolle* Blackburn; D, *atropolitum* Gillet; E, *lewisense* sp. nov.; F, *reyi* Paulian. Not to scale.

setae; endophallus with roughly C-shaped basal sclerite and appendage, short and narrow ring sclerite without appendage, strongly lobed median sclerite.

Female (Figs 23L, 24D). Spermathecal sclerite divided into two feebly sclerotised smooth ridges, separated by base of spermathecal duct; spermatheca falcate, gradually narrowed to pointed apex.

REMARKS. Contrary to Paulian's observations (1985: 224), this is a typical member of *Temnoplectron*, sharing many character states with several Australian congeners and *T. wareo* sp. nov.

DISTRIBUTION AND BIOLOGY (Fig. 25). *Temnoplectron aeneolum* was described from Fly River (Lansberge 1885), from material collected by D'Albertis in either November-December 1875 or May-July 1876, within 580km of the mouth of the Fly River (Goode 1977). This area is a mosaic of swamp forest and savannah woodland. It also occurs in a similar range of habitat at 3-700m altitude near Port Morseby (Paulian 1985).

Temnoplectron aeneopiceum Matthews
(Figs 3D, 5A, 8G-H, 13D-F, 19B, 21C, 23C, 24F, 26)

Temnoplectron aeneopiceum Matthews, 1974: 157; Cassis & Weir, 1992: 170

TYPE. Holotype: Paluma Dam Rd, Mt Spec, 30.iii.1968, EM (ANIC). Examined.

MATERIAL. (479) NORTH QUEENSLAND: Birthday Ck Falls (ANIC, BMNH); Bluewater Ra (QM); Boulder Ck, Tully (QM); 32km NW Cardwell (ANIC); Charmillin Ck (QM); 40km W Ingham (ANIC); 22km NE [sic, = NW?] Kennedy (ANIC); Kirrama Ra. (JCU, QM); Kjellberg Rd turnoff (QM); Lamins Hill (QM); Malaan Rd, 2km off H'way (QM); Malaan SF (QM); Millaa Millaa Falls (QM); Mt Father Clancy (QM); Mt Fisher (QM); Mt Graham, Cardwell Ra. (QM); Mt Halifax (JCU, QM); Mt Hugh Nelson (QM); 7km S Mt Kootoomool (QM); Mt Macalister (QM); Mt Spec (ANIC, JCU); 2 mi W Mt Spec (DPIM); Palmerston NP (QM); Paluma (ANIC, JCU); 3mi E Paluma (paratype; ANIC); 6km WNW Paluma (ANIC); 10km W Paluma (ANIC); 12km E Paluma (ANIC); Paluma Dam Rd (including 27 paratypes; ANIC, QM); Ravenshoe SF (ANIC); 11km & 18km SSW Ravenshoe, Tully Falls SF (DPIM); 9km NE Ravenshoe (DPIM), 18km SSW Ravenshoe (DPIM); Smoko Ck (JCU); Tully Falls (AMS, QM); Tully R Dam (QM); Tully R Xing (QM); 1.5km N Tully R Xing (QM); Upper Boulder Ck (QM); Wallaman Falls Rd (QM); Windy Post (ANIC); Wongabel, 6km S Atherton (DPIM); Wongabel, 7km S Atherton (ANIC); Yuccabine Ck (QM)

DESCRIPTION (male). *Colour.* Black, elytra dark greenish, appendages dark reddish-brown.

Length. 5.0-6.5mm.

Head (Fig. 3D). Strongly and almost evenly but relatively sparsely punctured, strongly microreticulate; frontoclypeus not rugosely punctured towards anterior margin, which is evenly shallowly curved between genal angles and median teeth; eyes large, broadest at middle, interocular ratio 4.5-5; first segment of labial palpi 1.25 × length of second.

Thorax (Figs 5A, 8G, 13D-E). Pronotum: strongly and closely punctured, disc shining, shallowly or not microreticulate, sides strongly microreticulate; disc not anteriorly depressed; lateral margins pronotum complete; hypomeral ratio 0.2-0.4; elytra entirely microreticulate, usually strongly and evenly so, rarely shallower in basal half; intervals moderately strongly punctured; apical half stria 1 punctate but not depressed; striae 1-7 with sparse foveolate punctures on apical half, rarely to base of elytra; basal third of elytra with 10 striae, 8th effaced in apical half, rarely apical 0.7; stria 8 abbreviated by 1-2 × mesepimeron length; base of epipleuron not constricted; macropterous; meso-metasternal margin with almost flat triangular median tubercle; metasternum strongly punctured throughout, shining except anterior of median lobe microreticulate, anterior corners of lobe with narrow triangularly expanded margins; fore tibia outer margin with three acute major teeth separated by 3-7 sharp or convex minor teeth (varies within individuals), inner margin almost straight; mid femur elongate-ovate; hind tibia evenly curved, outer face abruptly or gradually contracted towards base, almost parallel-sided for apical half; hind tibial spine sharply pointed, tibial spine ratio 0.75-1.5, with apical spur as long as first tarsal segment; hind tarsi long, c.0.3 × length hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19B, 21C). Ventrites 1-5 with basal row of small sensory pits; last two ventrites with shallowly impressed impunctate boundary; basal margin of pygidium evenly curved or rarely with median swelling; parameres without setal fringe, roughly sinusoidal with deep ventral excavation towards base, but asymmetric, left with obliquely truncate apex, apex dorsally minutely toothed and ventrally produced; right paramere not dorsally notched, gradually constricted to blunt inwardly folded apex; endophallus: basal sclerite pear-shaped with angular lateral lobe and small adjacent sclerite; flagellum long, lobes not equidistant; ring sclerite with thick-walled narrow ring and laterally flared lobe; median sclerite triangular but split by median cleft.

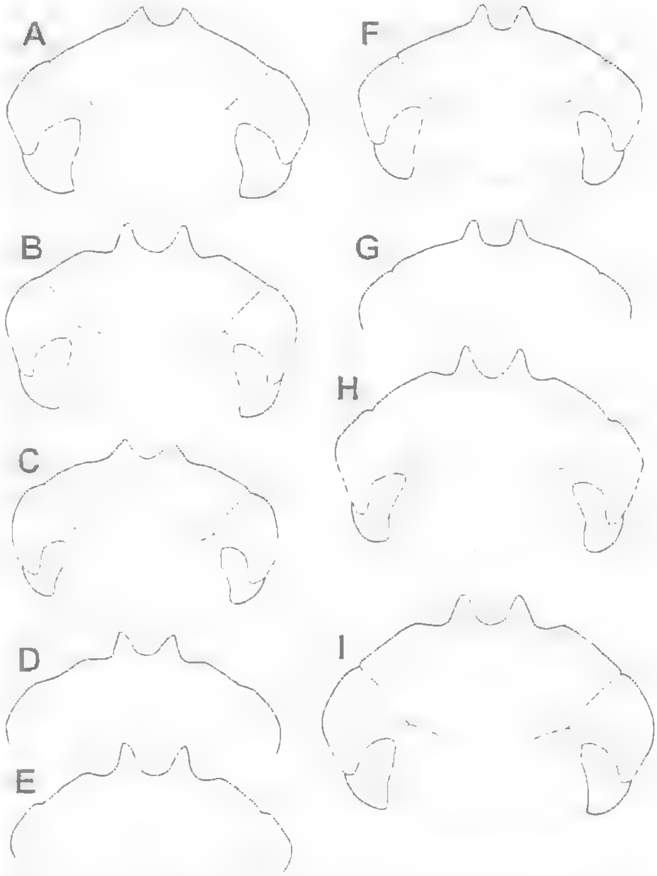

FIG. 2. *Temnoplectron* species, *rotundum* species group, dorsal view of head; A, *bornemisszai* Matthews; B, *boucomonti* Paulian (holotype *laevigatum* Matthews); C, *boucomonti* (worn specimen, Dimbulah); D, *boucomonti* (PNG); E, *boucomonti* (Cairns); F, *laeve* (Laporte) (Windsor Tbld); G, *laeve* (Paluma); H, *major* Paulian; I, *rotundum* Westwood. All to same scale.

Female (Figs 8H, 13F, 23C, 24F). As above, except: inner half of elytra (intervals 1-4, or 5) microreticulate and dull (intervals 1-4, or -5), contrasting with shining, non-microreticulate outer half (intervals 5- or 6-10); fore tibial spur slightly flattened, attenuated to curved apex; hind tibia with short apical lobe, less than half apical tibial width; genitalia: spermathecal sclerite a transverse weakly sclerotised, broad ridge, translucent around orifice; spermatheca small and C-shaped, with slightly swollen base and thin curved apex.

REMARKS. A detailed description is given here because this species was not clearly distinguished from *T. subvolitans* when originally described (Matthews, 1974). Two paratypes of *T. aeneopiceum* (from Mount Lewis) belong to *T. subvolitans*.

DISTRIBUTION AND BIOLOGY (Fig. 26). Present all year, but most active or abundant during the wet season, from December to April (Hill, 1993). This species commonly perches low on vegetation at night and is attracted to light (Howden et al., 1991). Widespread and common in rainforest from Bluewater Range north to the southern end of the Atherton Tableland, where it

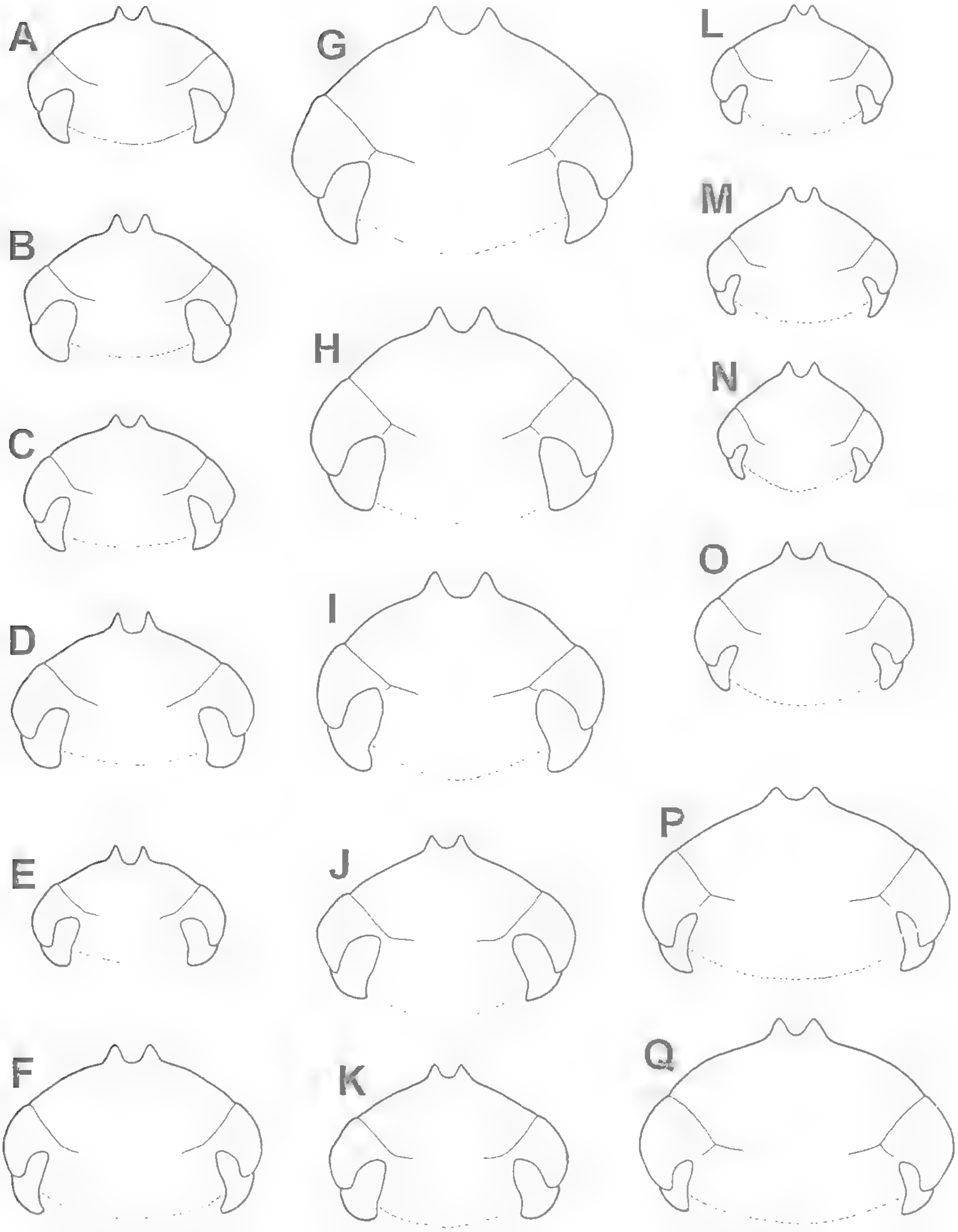

FIG. 3. *Temnoplectron* species, dorsal view of head; A, *aeneolum* Lansberge; B, *wareo* sp. nov.; C, *disruptum* Matthews; D, *aeneopiceum* Matthews; E, *subvolitans* Matthews; F, *diversicolle* Blackburn; G, *atropolitum* Gillet; H, *heurni* Paulian; I, *howdeni* Paulian; J, *politulum* Macleay; K, *reyi* Paulian; L, *involucre* Matthews; M, *lewisense* sp. nov.; N, *monteithi* sp. nov.; O, *finnigani* sp. nov.; P, *cooki* sp. nov. (Mt Spurgeon); Q, *cooki* (Mt Haig). All to same scale.

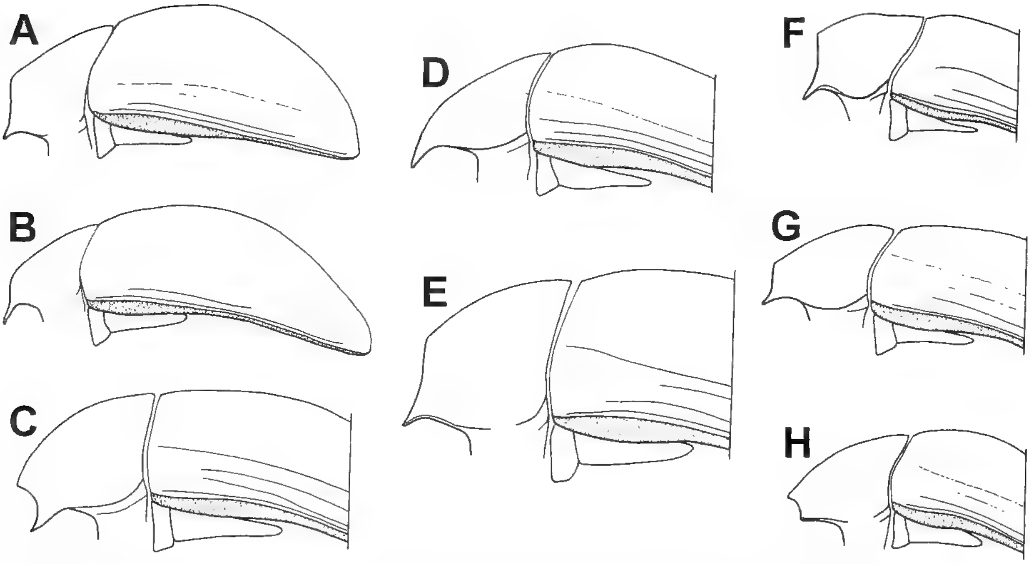

FIG. 4. *Temnoplectron* species, lateral view of thorax; A, *aeneolum* Lansberge; B, *wareo* sp. nov.; C, *boucomonti* Paulian; D, *laeve* (Laporte); E, *diversicolle* Blackburn; F, *atropolitum* Gillet; G, *finnigani* sp. nov.; H, *cooki* sp. nov.; epipleuron stippled. Not to scale.

overlaps slightly with its sister-species, *T. subvolitans*.

Temnoplectron atropolitum Gillet
(Figs 1D, 3G-I, 4F, 6A, 9A-D, 12D, 13I-K, 17K-M, 20A, 23B, 24C, 25)

Temnoplectron atropolitum Gillet, 1927: 252; Paulian, 1934: 285; Paulian, 1985: 224.
Temnoplectron heurni Paulian, 1985: 225; syn. nov.
Temnoplectron howdeni Paulian, 1985: 227; syn. nov.

TYPES. Lectotype of *T. atropolitum* (in DEB), designated by Paulian (1985) from Dormanpadbivak, not seen, but contemporary topotypic material examined. Holotype of *T. heurni* not examined (in DEB). Holotype of *T. howdeni* not seen (in CMN), but part of the same series (topotypic) examined.

MATERIAL. (336, only those examined in detail listed) INDONESIA: 4, Dormanpadbivak, 1410m, x.1920, W.C. van Heurn (ANIC, MZB); 1, Freeport Concession, Timika, 4.76145°S 136.86369°W[sic], inner mature mangrove, dung pitfall, 15m, 16.iii.1997, Ubaidillah (MZB); 1, ditto, except 4°39'43"S 136°53'50"E, peat swamp, 13-16.iii.1997 (MZB); 4, ditto, except 4°17'23"S 138°59'98"W[sic], open heath forest, 600m, 11-14.iii.1997 (MZB); 1, Jayawijaya, Kelila, Wurigelebur primary forest, pan trap, 1300m, 6-26.x.1995, E. Cholik, A. Suyanto, A. Saim (MZB); 2, ditto except 1500m (MZB); PAPUA NEW GUINEA: 3, Western Highlands, Mt Hagen, oak forest dung traps, 6000'[1800m], 5-8.vii.1974, S. Peck (CMN, DPIM).

DESCRIPTION (male). *Colour.* Black, appendages reddish-brown.

Length. 8-10mm. Body relatively elongate (Fig. 1D).

Head (Fig. 3G-I). Lemon-shaped, anterior margin of frontoclypeus evenly curved between genal angles and median teeth, except slight nick at base of clypeus; frontoclypeus impunctate or apparently so (sometimes minute punctures visible at ×50), densely and evenly finely microreticulate, shining but duller than pronotum; eyes large, interocular ratio 3.7-5.3; first maxillary palp segment 1.2-1.5× length of second segment.

Thorax (Figs 4F, 6A, 9A, 9C-D, 12D, 13I-K). Pronotum shining, shallowly or obscurely microreticulate, minutely and sparsely punctured; pronotal disc anteriorly slightly depressed or evenly convex; lateral margin of pronotum entire to completely obliterated from base to junction with femoral hollow, often with dorsal triangular thickened area at extreme lateral edge (abraded in old specimens?); hypomeral ratio 0.25-0.4; elytra shining, shallowly or obscurely microreticulate, intervals finely punctured; elytral striae 1-6 absent or feebly impressed on elytral disc, shallowly impressed in apical third or with scattered deep foveolate punctures, striae 5-6 sometimes almost entirely punctate; stria 7

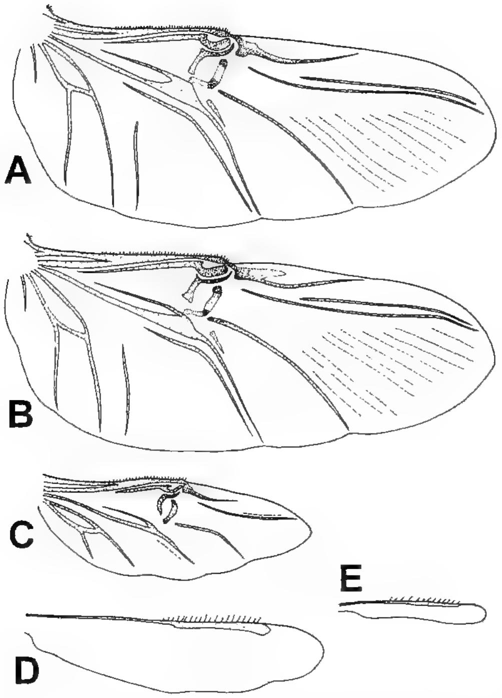

FIG. 5. *Temnoplectron* species, wings; A, *aeneopiceum* Matthews; B, *subvolitans* Matthews (Mt Spurgeon); C, *subvolitans* (Malaan SF); D, *cooki* sp. nov.; E, *finnigani* sp. nov.

absent or almost effaced, with vague foveolate depressions; stria 8 present in middle third of elytra as impressed groove with fine ridge, abbreviated from base by 3-5 × length mesepimeron; stria 9 abbreviated by 2-2.5 × length mesepimeron; base of epipleuron not constricted; macropterous; meso-metasternal suture without median tubercle; metasternum impunctate, margins of anterior lobe narrow, usually partly obliterated; inner margin fore tibia slightly expanded in middle and shallowly to somewhat abruptly excavate at base, with adjacent sharp ridge along apical half of outer face (abraded in old specimens); outer margin fore tibia with 2-3 broad and slightly convex minor teeth between acute major teeth; mid femur elongate-ovate; hind femur elongate-ovate, broadest about middle; hind tibia almost straight, slightly curved, with preapical swelling on inner margin; tibial spine short and triangular, without apical spur, tibial spine ratio 0.5-0.75; hind tarsi long, 0.45-0.5 × length hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

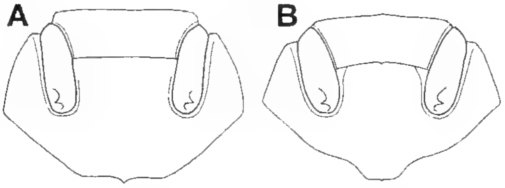

FIG. 6. *Temnoplectron* species, mesosternum, mesocoxae and metasternum; A, *atropolitum* Gillet; B, *cooki* sp. nov. Both to same scale.

Abdomen (Figs 17K-M, 20A). Pygidium entirely shining or basal half shallowly microreticulate, basal margin evenly margined, not medially swollen; last two ventrites separated by deep groove with row of large punctures (sensory pits); parameres without setal fringe, asymmetric, sinuate, abruptly contracted at middle towards narrow apical half, apex left paramere rounded, apex right with prominent basal lobe; endophallus: ring sclerite with narrow diameter thick ring and large appendage; basal sclerite dense and opaque, feebly folded, roughly quadrate; median sclerite roughly triangular, irregularly lobed and deeply medially split.

Female (Figs 9B, 23B, 24C). Pronotal disc evenly curved, lateral margins never partly thickened; inner margin of fore tibia straight, without ridge on apical half of outer face; spermathecal sclerite absent, without smooth or darker areas around base of spermathecal duct; spermatheca falcate, with globular base, constriction before middle, and almost parallel sided apical lobe.

REMARKS. This species was described three times from small samples. The three species were supposedly distinguished by absence of lateral pronotal margins (*T. howdeni*), or elytra more (*T. heurni*) or less (*T. atropolitum*) strongly punctured (Paulian, 1985). We have seen 320 specimens recently collected between Timika and Kelila in central West Papua (ZMB), which show the full range of variation in the three described species. This variation is not linked to altitude or habitat. Male genitalia of all dissected specimens are almost identical and there are no obvious secondary sexual differences. We therefore feel justified in synonymising the three species.

A specimen from Adelbert Range (ANIC), north-central Papua New Guinea, differs slightly from all other material of *T. atropolitum*. It has

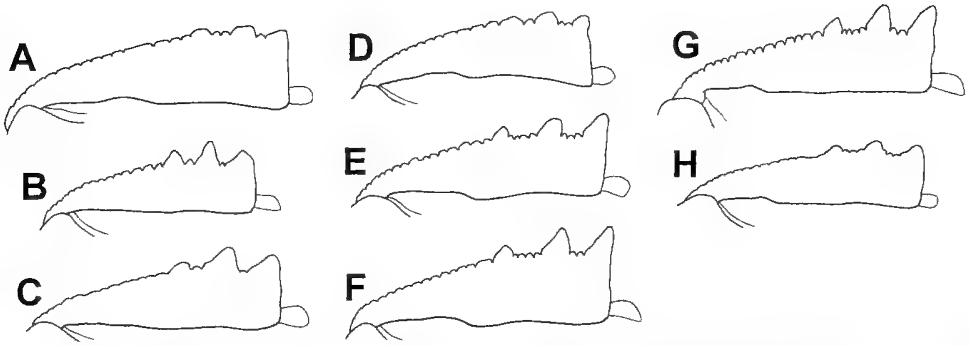

FIG. 7. *Temnoplectron* species, *rotundum* species group, ♂ fore tibia; A, *bornemisszai* Matthews; B, *boucomonti* Paulian; C, *boucomonti* Paulian (worn specimen); D, *laeve* (Laporte); E, *major* Paulian (Mt Spurgeon); F, *major* Paulian (Paluma); G, *rotundum* Westwood; H, *rotundum* Westwood (worn specimen). All to same scale.

more strongly punctured elytra and an entirely shining dorsal surface, but the eye shape (Fig. 3H), front tibia (Fig. 9C), hind tibia (Fig. 13J) and male genitalia (Fig. 17L) are typical of *T. atropolitum*. Specimens of *T. atropolitum* recorded from Aru Islands (Paulian 1985), not far from Timika, have not been examined but are probably correctly identified.

DISTRIBUTION AND BIOLOGY (Fig. 25). Occurs from 15-1800m across New Guinea, from Timika to Mount Hagen and the Adelbert Range. It has been collected in peat swamp, heath forest, *Lithocarpus* forest and montane primary rainforest at human dung baited traps.

Temnoplectron bornemisszai Matthews

(Figs 2A, 7A, 11A, 11G, 14A, 17A-B, 20G, 24B, 27)

Temnoplectron bornemisszai Matthews, 1974: 149; Cassis & Weir, 1992: 170.

TYPE. Holotype: Yungaburra, 7.v.1969, GB, DIC (ANIC). Examined.

MATERIAL. (651, abbreviated localities only) QUEENSLAND: 6km (4mi) S Atherton (ANIC, DPIM); 21km NE Atherton (ANIC, QM); Baldy Mt (DPIM); Bartle Frere, west base (QM); Boar Pocket Rd (ANIC); 32km NW Cardwell (ANIC); Cedar Pocket (ANIC); Charmillin Ck (QM); Chujeba Peak (QM); Curtain Fig (ANIC, QM); 12km SE Daintree (ANIC); Danbulla Reserve (QM); Davies Ck (JCU, QM); Evelyn (QM); Gadgarra SF (QM); Kauri Ck (QM); Kenny Rd (QM); Kirrama Ra (DPIM, JCU, UQ); Lake Eacham (QM); Maalan SF (QM); Massey Ck (ANIC, JCU); Millaa Millaa (AMS); Millaa Millaa Falls (DPIM); Mossman Bluff (QM); Mt Boolbun South (QM); Mt Father Clancy (QM); Mt Formatine South (QM); Mt Haig (ANIC); 5-5.2km SSW Mt Haig (QM); Mt Hartley (QM); Mt Hosie (ANIC, QM); 16 & 22km up Mt Lewis Rd (QM); Mt Macalister (QM); Mt Murray Prior (QM); Mt Nomico (AMS); Mt Sampson (QM); Mt Smoko (QM); Mt Spurgeon (ANIC, QM); 2-3km SW Mt Spurgeon (QM); Mt Williams (QM); Palmerston NP (DPIM, UQ); Peeramon Scrub (DPIM); Quaid Rd, 11km from quarry (DPIM); Ravenshoe SF (ANIC); 9.5 & 18km SSW Ravenshoe (DPIM); Saddle Mt (QM); South Johnstone Forestry Camp (QM); The Crater (DPIM, UQ); Topaz (QM); Tully Falls SF (DPIM, QM, UQ); 1.5km N Tully R Crossing (QM); Upper Boulder Ck (QM); Upper Stewart Ck (paratype; ANIC); Windsor Tbld (ANIC, DPIM, QM); Windy Post (ANIC); Wongabel SF (QM); Yungaburra (2 paratypes; ANIC); 2mi S Yungaburra (DPIM, UQ); 13km NE Yungaburra (DPIM).

DESCRIPTION (male). *Colour.* Body and appendages black, except mouthparts, antennae and tarsi reddish-brown.

Length. 9.5-13mm.

Head (Fig. 2A). Frontoclypeus dull, strongly microreticulate, entirely finely punctate, or slightly rugose at extreme anterior margins; frontoclypeal margin straight, not convex or produced between genal angles and median teeth, but slight nick present at junction of frons and clypeus; eyes large, interocular ratio 3.3-4.0; basal segment of labial palp 1.5-2 × length second segment.

Thorax (Figs 7A, 11A, 11G, 14A). Pronotum dull, strongly microreticulate and finely punctured, disc not medially depressed; lateral margins of pronotum complete; hypomeral ratio 0.4-0.5; elytra dull, strongly microreticulate, intervals with obscure punctation; striae 1-7 with minute slightly foveolate punctures, stria 1 not apically deepened; elytra of major male swollen at base of 5th interval; 8th elytral stria present, base of stria 8 abbreviated by 0.5-0.75 × length mesepimeron, stria 9 similar; base of epipleuron not constricted; macropterous; meso-metasternal

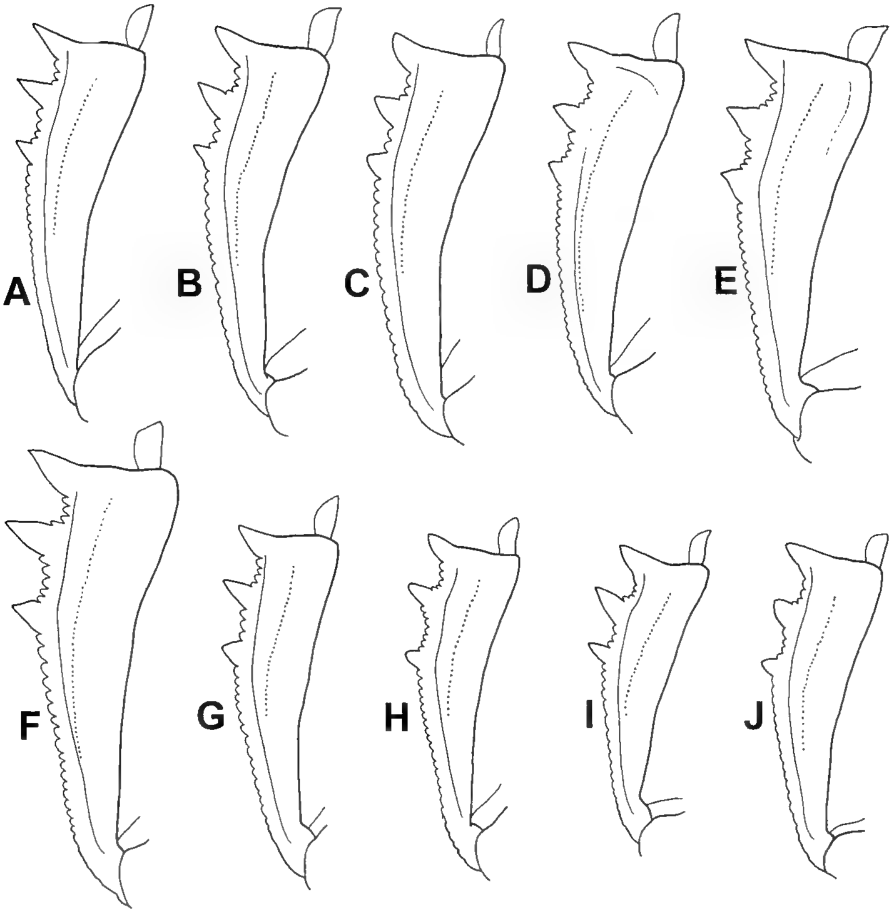

FIG. 8. *Temnoplectron* species, fore tibia (♂ unless otherwise noted); A, *aeneolum* Lansberge; B, *wareo* sp. nov.; C, *wareo*, ♀; D, *disruptum* Matthews; E, *diversicolle* Blackburn; F, *cooki* sp. nov., G, *aeneopiceum* Matthews (Cardwell Range); H, *aeneopiceum*, ♀ (Mt Kooroombool); I, *subvolitans* Matthews, ♀ (Bartle Frere); J, *subvolitans* (Mt Spurgeon). All to same scale.

suture without median tubercle; anterior of metasternal process without triangularly expanded margins; outer margin fore tibia with short and obtuse major teeth, separated by 1-2 convex minor teeth; inner margin fore tibia abruptly emarginate 0.3-0.5 from base; mid femora broadest in apical half, venter evenly curved, not lobed at apex; hind femora broadest in apical half, then gradually attenuated to apex; hind tibial spine elongate, equal to length of tarsal segments 1-3, thick and blunt, with small articulated spur present; tibial spine ratio 1.5-2; length hind tarsus c.0.25 × tibia, segments 1-2 ventrally lobed, length 1=2, 3=4, 5<3+4.

Abdomen (Figs 17A-B, 20G). Basal border of pygidium with median swelling; suture between last two ventrites not or weakly grooved; parameres without apical setal fringe, almost symmetrical, narrow and almost parallel-sided, apices bluntly rounded with short ventral teeth; endophallus: ridges of flagellum strongly lobed; basal sclerite roughly quadrate, opaque and feebly folded; ring sclerite with narrow thick ring and curved appendage; median sclerite irregular, strongly folded; apex of endophallus with patch of spinules.

Female (Figs 11A, 24B). Mid femur elongate-ovate, with evenly curved dorsal and ventral margins; genitalia: spermatheca C-shaped, with

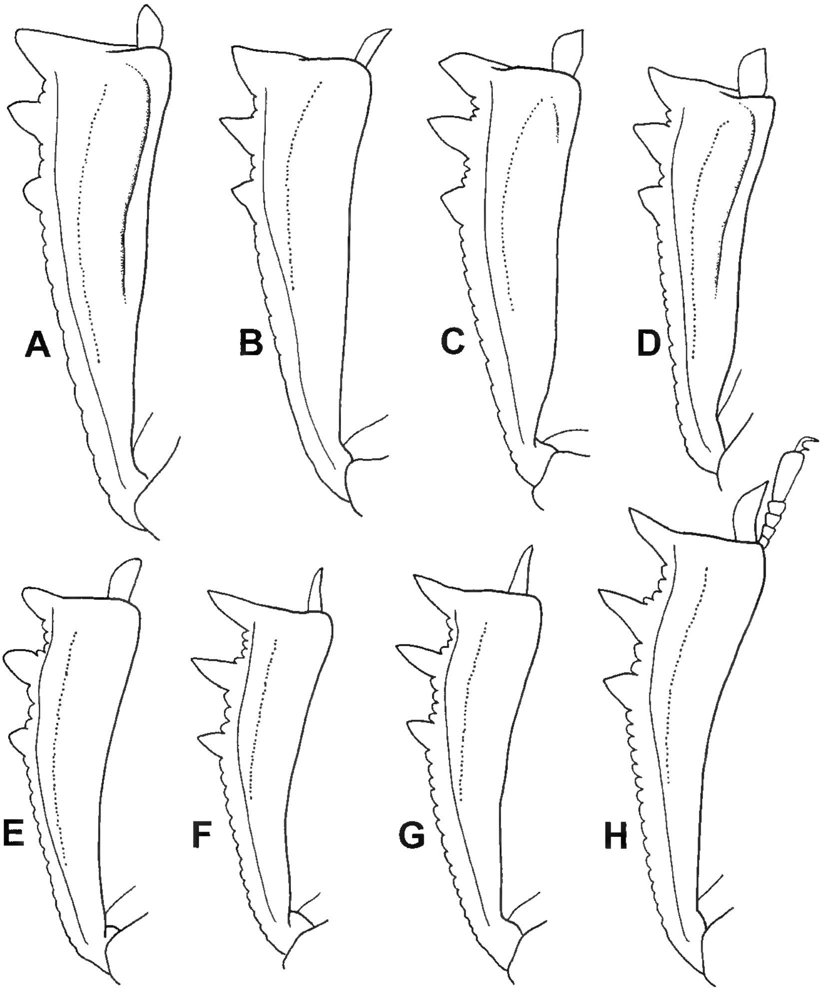

FIG. 9. *Temnoplectron* species, fore tibia (♂ unless otherwise noted); A, *atropolitum* Gillet (worn topotype); B, *atropolitum*, ♀ (worn); C, *atropolitum* Gillet (Adelbert Range); D, *atropolitum* Gillet (Mt Hagen); E, *reyi* Paulian (worn); F, *reyi*, ♀; G, *politulum* Macleay, ♀; H, *politulum*. All to same scale.

bulbous basal half; spermathecal sclerite narrow, a feebly sclerotised, ridge.

DISTRIBUTION AND BIOLOGY (Fig. 27). A common species from Cardwell Range to the Mount Finnigan region, north Queensland. It is confined to rainforest and is an active flier, attracted to light (Hill, 1996). It does not appear to perch, unlike other *Temnoplectron* species (Howden et al., 1991).

Temnoplectron boucomonti Paulian
(Figs 2B-E, 4C, 7B-C, 11B, 11H, 12A, 12F, 14B-D, 16A, 17C-D, 20C-D, 28).

Temnoplectron boucomonti Paulian, 1934: 285; Paulian, 1985: 224.
Temnoplectron yuleanum Balthasar, 1965: 15; Paulian, 1985: 224 (synonymy).
Temnoplectron laevigatum Matthews, 1974: 150; Cassis & Weir, 1992: 171; syn nov.

TYPES. Holotype of *T. laevigatum* Matthews: 1-17mi N Adelaide R, 12.ii.1968, EM (ANIC). Examined. Types of *Temnoplectron boucomonti* (in MNHN) and *T. yuleanum* (in NMP) have not been examined but were adequately described for recognition of this species.

MATERIAL. (220, data reduced to locality, altitude, date, collector) AUSTRALIA: NEW SOUTH WALES: 1, Congo, 8km ESE Moruya, 30.xii.1981, MU (ANIC) [labelled: 'locality data incorrect']; NORTHERN TERRITORY: 3, Adelaide R, 4.iii.1972, 23.iv.1976, J. Wombey, K. & E. Carnaby (ANIC); 68 paratypes *T. laevigatum*, 1-17mi N Adelaide R, 12.ii.1968, EM (ANIC); 1, 17mi S Adelaide R, 7.iv.1971, TW (UQ); 2, 40mi S Adelaide R, 25.i.1971, TW & A. Allwood (UQ); 1, Berrimah, 3.xii.1973, R. Fox (UQ); 12, Black Pt, Coburg Peninsula, 29.i-23.ii.1977, TE, TW (ANIC); 2, Brook Ck, Burnside, 30.iii.1929, T.G Campbell (paratypes *T. laevigatum*; ANIC); 2, Cutta Cutta, iv.1987, S. Churchill (AMS); 4, Daly R Crossing, 22.i.1974, J.F. Hutchinson (ANIC); 4, Daly R mission, 22.i.1972, 10-20.v.1974, 8-24.vi.1974, J. Hutchinson (ANIC); 2, Darwin, 1945, S.R.E. Brock (ANIC); 35, 15-27mi S of Darwin, 29.i.1968, EM (paratypes *T. laevigatum*; ANIC); 2, Delamere, 20-25.v.1968, M. Mendum (ANIC); 1, Dingo Ck, Victoria H'way, 1.i.1992, MBM (AMS); 3, Groote Eylandt, N.B. Tindale (2 paratypes *T. laevigatum*; ANIC); 1, Howard Springs, 27-29.i.1968, EM (paratype *T. laevigatum*; ANIC); 1, Humpty Doo, 28.xi.1974, RS (DPIM); 10, 6km E Humpty Doo, 9.ii-4.iii.1987, 6-19.x.1990, RS (DPIM); 5, 2-4mi E Katherine, 8.ii.1968, EM (paratypes *T. laevigatum*; ANIC); 1, 15mi N Katherine, 8-9.iii.1978, Bainbridge (ANIC); 3, Mary R, Arnhem Highway, 27-29.xi.1978, RS (DPIM); 1, Mataranka Homestead, 16-18.xi.1974, RS (DPIM); 1, 7km W Pickertarimoor, Melville I., 16.i.1990 (SAM); 1, Port Darwin (AMS); 1, Smith Pt, Coburg Peninsula, 26.i.1977, EE (ANIC); 1, South Adelaide R, 23.iv.1976, Carnaby & Carnaby (DPIM); 1, Tindal, 5.xii.1967, W.J.M. Vestjens (ANIC); 1, Whitestone Stud, Adelaide R (ANIC); QUEENSLAND: 1, Bald Mt, Emu Vale, 17-22.v.1969, B.H. Kay (UQ); 1, Cairns, iv.1939, [JGB coll.] (ANIC); 1, Canungra Ck, 20-22.i.1987, GM (QM); 8, Carmila, i.1926, 1928, MacArthur (AMS); 1, Duaringa, 8.iii.1946, L.A. Smith (ANIC); 1, Eureka Ck, 9km SW Dimbulah, 20.xi.1981, J. Balderson (ANIC); 4, Forest Hill, Gatton, 4-12.xi.1976, M. Tichon (DPIM); 1, Mingela, 21.iv.1955, Norris & IC (paratype *T. laevigatum*; ANIC); 2, Mitchell R, 1927, J. Done (AMS); 1, Morehead R, Coen Rd, 10.vi.1960, C. N. Smithers (paratype *T. laevigatum*; AMS); 1, Pistol Gap, Byfield, 10.i.1970, EB, GH & SM (ANIC); 1, Sarina (ANIC); 2, Silver Plains HS, 28.xii.1968, JW (1 paratype *T. laevigatum*; ANIC); 1, Stewart R, i-ii.1927, Hale & Tindale (paratype *T. laevigatum*; ANIC); 2, Yenyorondi, S.R.E. Brock (ANIC); 4, Yeppoon, 14-15.xii.1964, 28.xii.1964, 1.xii.1965, J.C. Le Souef, IC (ANIC); WESTERN AUSTRALIA: 1, East Kimberley, M. Durack (paratype *T. laevigatum*; ANIC); 1, Ivanhoe Station, 1949 (WAM); 1, Kununurra, 22.xii.1991-6.i.1992, RS (DPIM); 2, Wyndham, ii.1954 (ANIC); PAPUA NEW GUINEA: 1, Aroa R (BMNH); 7, Mt Lawes, Port Moresby, 5.iii-12.v.1963, 1300', W.W. Brandt (ANIC); 1, Owgarra, coll. Meek (BMNH); 4, Rouku, Morehead R, 19.iii-28.v.1962, W.W. Brandt (ANIC); 1, Western Districts (UQ).

DESCRIPTION (male). *Colour.* Body and appendages black, except mouthparts, antennae and tarsi reddish-brown.

Length. 7.5-11.5mm.

Head (Fig. 2B-E). Eyes large, interocular ratio 5-6.5; basal segment of labial palpi 1.5-2× length of second segment; anterior margin of frontoclypeus with slight emargination at junction of frons and clypeus, and convexly produced (or concavely excised) lateral to median teeth; frontoclypeus dull, strongly microreticulate and punctured, becoming rugose towards anterior.

Thorax (Figs 4C, 7B-C, 11B, 11H, 12A, 12F, 14B-D). Disc of pronotum strongly punctured, shining, without obvious microreticulation or shallowly microreticulate, not medially depressed, without lateral tubercles; pronotal lateral margins complete; hypomeral ratio 0.7-0.9; elytral disc shining or dull, intervals finely or obscurely punctured and shallowly to strongly microreticulate; elytral striae 1-7 with small foveolate punctures, stria 1 not apically deepened; whole venter densely microreticulate; stria 8 present, abbreviated at base by 1-2× length mesepimeron, stria 9 similar; base of epipleuron not constricted; macropterous; whole venter strongly microreticulate; meso-metasternal border straight, without median tubercle, anterior lobe of metasternum with narrow margins; outer margin fore tibia with acute major teeth, separated by 1-2 convex minor teeth; inner margin fore tibia straight, or slightly angulate, but not emarginate; ventral margin of mid femur strongly lobed in apical third, lobe angulate or rounded, not swollen on outer face; hind femur broadest 2/3 from base, abruptly contracted to apex; outer face of hind tibia evenly contracted to base; hind tibia almost straight in basal 2/3, strongly curved in apical third which is produced in a long apical spine, equal in length to tarsal segments 1-4, spine thick at base, tapering to sharp apex, without articulated spur; tibial spine ratio 1.5-2; hind tarsi short, c.1/6 length hind tibia, segments 1-3 ventrally lobed, length segment 1=2=3=4, 5=3+4.

Abdomen. Basal margin of pygidium evenly curved; suture between last two ventrites not or weakly grooved, without row of punctures; parameres without apical setal fringe, asymmetric, left paramere thick, bluntly curved or feebly angulate ventrally; right paramere dorsally excavate, apex with prominent flat lobe (a unique specimen, which was examined for this study, with much thinner parameres, was illustrated by Matthews (1974); other specimens from the same population are normal); endophallus: ridges of flagellum not strongly lobed; basal sclerite roughly quadrate, opaque and feebly folded; ring

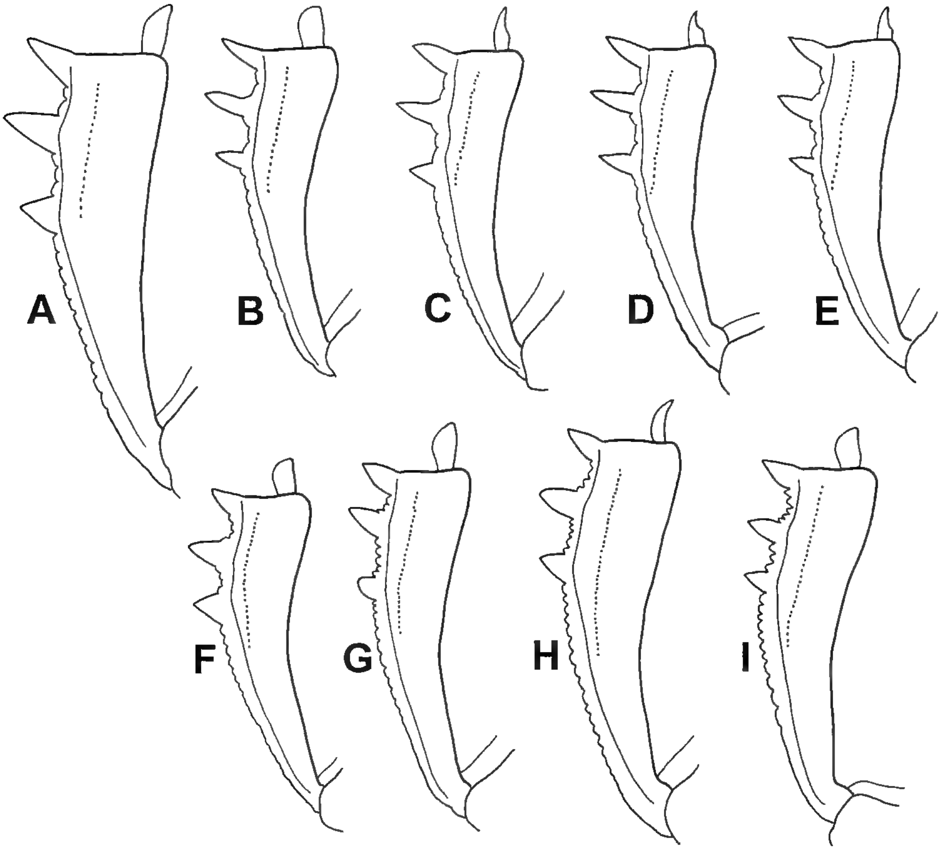

FIG. 10. *Temnoplectron* species, fore tibia (♂ unless otherwise noted); A, *finnigani* sp. nov.; B, *monteithi* sp. nov. (Cape Tribulation); C, *monteithi*, ♀ (Cape Tribulation); D, *monteithi*, ♀ (Mount Halcyon); E, *monteithi*, ♀ (Thornton Peak); F, *lewisense* sp. nov. (Devils Thumb); G, *lewisense* (Mt Lewis); H, *lewisense*, ♀ (Mt Lewis); I, *involucre* Matthews (Paluma). All to same scale.

sclerite with narrow thick ring and curved appendage; median sclerite irregular, strongly folded, almost split medially; apex of endophallus without spinules, but subapically with darker sclerotised patch.

Female (Fig. 11B). As above, except: mid femur broadest apically, with slight anterior expansion of ventral edge; spermathecal sclerite roughly straight-sided, but not sclerotised, width about 7× length; spermatheca constricted twice in basal half, base bulbous, apex relatively thin.

REMARKS. There is some variation in the shape of the clypeus (Fig. 2B-E) which has led to confusion of this species with *T. laeve*, but the anterior frontoclypeal margin in *T. boucomonti* is always convex. There is also variation in surface sculpture and development of secondary sexual characters, for example subapical lobe of the male mid femur, but the shape of the male hind tibia is diagnostic (Fig. 14B-D).

DISTRIBUTION AND BIOLOGY (Fig. 28). In Australia, widespread in the drier tropics and subtropics, from The Kimberleys in Western Australia to the Torres Strait and south to Canungra, Queensland, avoiding high rainfall areas of the Queensland coast. Its distribution generally encompasses that of *T. rotundum*, and overlaps slightly with *T. major*. *Temnoplectron boucomonti* is also widespread in the savannah woodland of SW Papua New Guinea, from Morehead River to Port Moresby area including Yule Island (Paulian, 1934; Balthasar, 1965), and at Owgarra, Anva River (Paulian, 1934).

Temnoplectron cooki sp. nov.
(Figs 1B, 3P-Q, 4H, 5D, 6B, 8F, 15F-G, 16C, 19D-E, 22C, 23F, 24I, 29)

ETYMOLOGY. Named for Doug Cook, Queensland Museum, an indefatigable collector of dung beetles.

MATERIAL. HOLOTYPE, Y, QMT59013: NEQ 17B07S 145°33E, Mt Haig, 5.2km SSW, 6-10 Feb 1998, 1070m, GM & DC, open for., dung pitfall (QM). PARATYPES. (188) QUEENSLAND: 1, Davies Ck, 19km WSW [sic] Mareeba, malaise trap, 21.xii.1984-7.i.1985, RS & Titmarsh (DPIM); 1, 16km up Davies Ck Rd via Mareeba, 18.ii-3.iii.1983, RS & Titmarsh (DPIM); 1, 29km SE Mareeba, 1100m, 14-15.xii.1982, JT (ANIC); 61, 5.2km SSW Mt Haig, 17°07S 145°33E, open forest, dung pitfall, 1070m, 6-10.ii.1998, GM & DC (ANIC, DPIM, QM); 2, Mt Spurgeon [c3km S summit], 16°27S 145°11E, tall primary wet sclerophyll forest, perching on low vegetation at night, 1150m, 19-22.xi.1997, CR (ANIC); 5, ditto, except: human dung trap, GM (QM); 18, ditto, except, sclerophyll forest, 19-23.xi.1997, GM, DC & CB (QM); 38, ditto, except: pitfall trap, 1100m, 19.xi.1997-8.ii.1998, GM & DC (DPIM, QM); 6, ditto, except: 1110m (ANIC); 7, ditto, except: open forest, 20-22.xi.1997, DC (DPIM, QM); 5, ditto, except: 19-22.xi.1997 (QM); 7, ditto, except: 16°28S 145°12E, 1140m, 20.xi.1997-8.ii.1998, GM & DC (QM); 13, ditto, except: 1100m, 20-22.xi.1997 (QM); 14, Mt Tiptree, 17°03S 145°37E, cow dung, open forest, 13.vii.1984, B. Halliday (ANIC); 7, Tinaroo Ck Rd, 20mi SE Mareeba, in fungus, 17.i.1974, AWH (ANIC, DPIM); 2, ditto except 20mi up Rd, AMWH (UQ).

DESCRIPTION (male). *Colour.* Upper surface pure black, not bronzed.

Length. 5.5-7.5mm. Body short-ovate and strongly arched in profile (Fig. 1B), length:width ratio 1.25-1.45.

Head (Fig. 3P-Q). Lemon-shaped, lateral corners angulate to rounded, anterior margin slightly nicked at frontoclypeal junction then evenly shallowly curved to median teeth; anterior of frontoclypeus more finely punctured and densely microreticulate than base; eyes small, interocular ratio 11-12; lengths of first two labial palp segments equal or almost so.

Thorax (Figs 1B, 4H, 5D, 6B, 8F, 15F-G). Pronotum shining, not obviously microreticulate, sides strongly punctured (similar to metasternum); disc evenly convex; basal 2/3 lateral margins of pronotum straight; base pronotum evenly curved; lateral margin of pronotum either completely bordered or up to middle third missing; hypomeral stria short, ratio 0.2-0.4; elytra shining but microreticulate; sides of elytra evenly curved from base to apex; striae 1-7 faint; stria 1 with several apical punctures but not deepened; stria 8 reduced to widely separated punctures, or short grooves in basal half, or complete between basal quarter and apical half of elytra; stria 9 deep, abbreviated by 1-2 × length mesepimeron; stria 10 deep, abbreviated at length of mesepimeron from base; base of epipleuron not constricted; wing reduced to a narrow unfolded strip, 1/2-2/3 length elytra; mesosternum almost impunctate; meso-metasternal margin with small median triangular excision; median lobe metasternum finely and densely punctured (interspaces 1-2 × puncture diameters), often more coarsely in posterior half, margins triangularly expanded at corners; metasternum with broad shallow depression close to posterior border; outer margin fore tibia with acute major teeth and 3-6 convex minor teeth between these, inner margin almost straight; mid femur elongate-ovate; hind femur with complete dorsal and ventral margins (ridges), almost parallel-sided but broadest c.1/3 from apex of trochanter; hind tibia almost evenly curved externally, with slight bulge 1/3 from apex on internal margin; apex of hind tibia produced, short spine equal to tarsal segments 1-2, pointed in dorsal view, with large subapical spur; tibial spine ratio 1-1.25; hind tarsi c.0.25 length of hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 0.75 × length segments 3+4.

Abdomen (Figs 16C, 19D-E, 22C). Suture between last two ventrites not or weakly grooved, without row of punctures; basal margin of pygidium evenly curved, not medially produced; parameres without apical setal fringe, asymmetric, excavated at base of venter, blunt tipped in profile, left paramere narrower and apex rounded, right paramere truncate, incurved at tip; endophallus: basal sclerite C-shaped, with an appendage; flagellum with three equidistant lobes; ring sclerite with thick narrow-diameter ring and large curved appendage; median sclerite, two strongly folded and irregular plates around median cleft.

Female (Figs 23F, 24I). Spermathecal sclerite not well defined, but vaguely darker square around vagina; spermatheca C-shaped, gradually contracted to blunt apex.

REMARKS. This species is similar to *diversicolle* Blackburn, but differs most obviously in its more rounded body shape. There are two discrete populations on mountain ranges in north Queensland, separated by 80km of lower, drier forest. Specimens of the northern population,

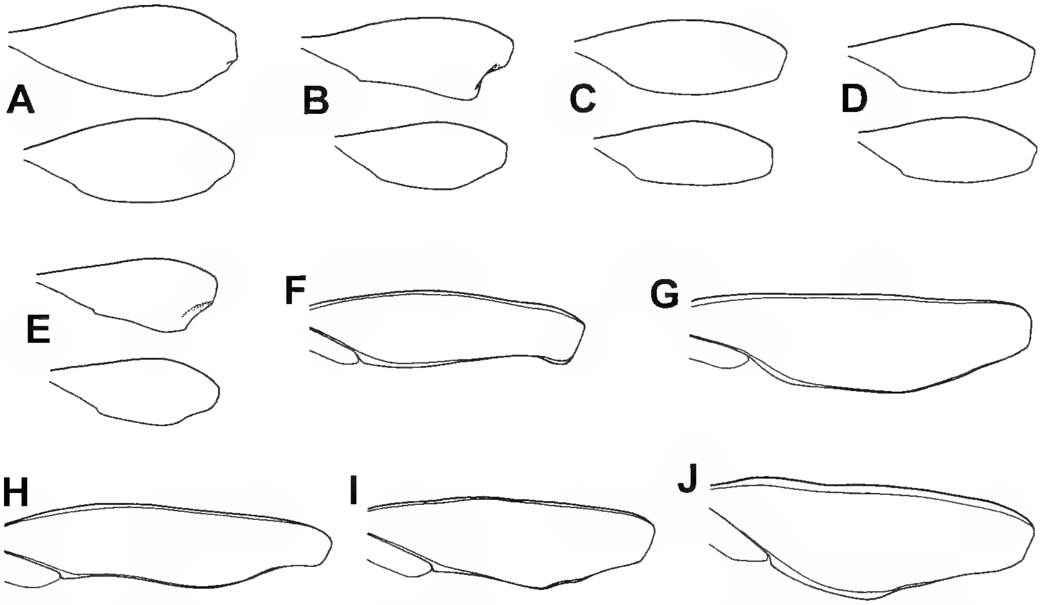

FIG. 11. *Temnoplectron* species, *rotundum* species group: major ♂ (above) and ♀ (below) mid femora; A, *bornemisszai* Matthews; B, *boucomonti* Paulian; C, *major* Paulian; D, *rotundum* Westwood; E, *laeve* (Laporte); major ♂ hind femora: F, *rotundum*; G, *bornemisszai*; H, *boucomonti*; I, *laeve*; J, *major*. All to same scale.

centred on Mount Spurgeon, are on average slightly larger, with the 9th stria less abbreviated at the base, and with the head more strongly punctured than the southern population. The eye size (Fig. 3P-Q), male legs (Fig. 15F-G) and male (Fig. 19D-E) and female genitalia are identical in the two populations, which are treated here as one species.

DISTRIBUTION AND BIOLOGY (Fig. 29). This appears to be a wet sclerophyll forest specialist, occurring commonly in two isolated areas dominated by *Eucalyptus grandis*. Geoff Monteith and Doug Cook have searched for it in similar habitat further south between Ravenshoe and Koombooloomba without success. It perches on low vegetation at night, less than a metre above ground (pers. obs.).

Temnoplectron disruptum Matthews
(Figs 3C, 8D, 13C, 19A, 22A, 23G, 29)

Temnoplectron disruptum Matthews, 1974: 154; Cassis & Weir, 1992: 170.

TYPE. Holotype in QM, examined.

MATERIAL. (105) QUEENSLAND: 8km NW Bald Hill (ANIC); 11km NW Bald Hill (ANIC); Coen (paratype, ANIC), Gordon's Mine area (QM); Iron Ra (holotype and paratypes, DPIM, QM); Leo Ck Rd (QM); 9km NNW Lockhart R (ANIC); 11km ENE Mt Tozer (ANIC); West Claudie R (QM).

DESCRIPTION (male). *Colour.* Black, appendages reddish-brown.

Length. 4.5-5.5mm.

Head (Fig. 3C). Microreticulate and sparsely punctured, genae and middle of frontoclypeus more finely punctured and strongly microreticulate than base; frontoclypeal margin evenly shallowly curved from genal angles to median teeth; eyes large, interocular ratio 5.2-6.5; basal segments of labial palpi equal sized.

Thorax (Figs 8D, 13C). Pronotum shining and shallowly microsculptured on disc, duller and densely microreticulate at sides and base; pronotum mostly extremely finely punctured to impunctate, but with two patches of strong and close punctures on either side of anterior half; pronotal disc not medially depressed; lateral margin of pronotum entirely effaced, or almost so, from base to femoral cavity; hypomeral stria fine and curved, hypomeral ratio 0.25-0.5; elytra entirely microreticulate, but more shining with shallower microsculpture on disc; elytra strongly arched in profile, highest in basal half; striae 1-7 shallowly impressed, almost effaced; stria 1 not deepened at elytral apex, with or without

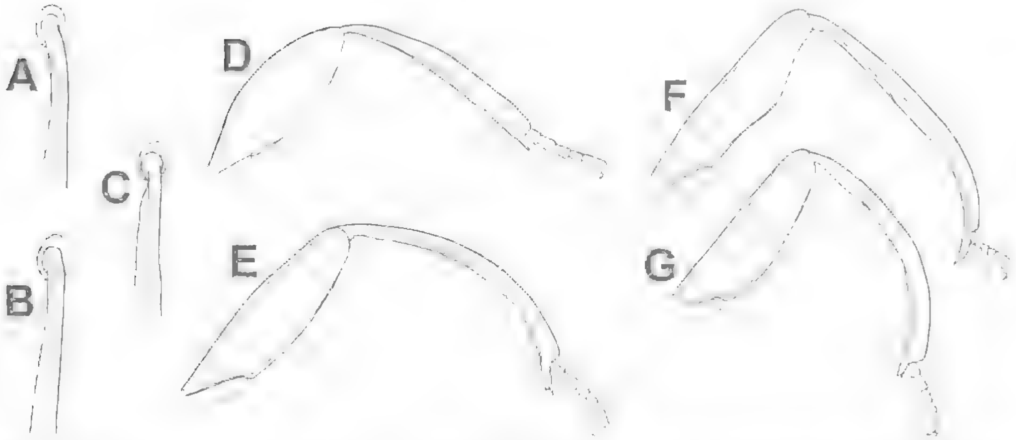

FIG. 12. *Temnoplectron* species: base of ♂ hind tibia, lateral; A, *boucomonti* Paulian; B, *major* Paulian; C, *rotundum* Westwood; whole hind leg: D, *atropolitum* Gillet; E, *reyi* Paulian; F, *boucomonti* Paulian; G, *finnigani* sp. nov.

scattered punctures; stria 8 absent, stria 9 abbreviated 2 × length mesepimeron, deep, with a bevelled edge for most of length; stria 10 deep, abbreviated 1 × length mesepimeron; upper margin of epipleuron not constricted at base; macropterous; meso-metasternal suture raised, with flat triangular tubercle at midpoint; median lobe of metasternum shining, without microsculpture except at extreme apex, finely and sparsely punctured, with margins triangularly expanded in apical corners; all femora elongate-ovate; anterior tibia with 3-5 convex minor teeth between acute major teeth, inner margin angularly bent one third from base; hind tibia curved, more strongly so in apical quarter, with elongate apical spine and prominent articulated spur, spine 1.5 × length first tarsal segment, tibial spine ratio 0.75-1.25; hind tarsi 0.3 × length hind tibia, segment 1 lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19A, 22A). Suture between last two ventrites not or weakly grooved, without row of punctures; basal border of pygidium evenly curved, not medially produced; parameres without apical setal fringe, almost symmetrical, without ventral teeth, both abruptly attenuated before truncate inwardly curved apices, but right larger than left, with broader apex; endophallus: basal sclerite solid, elongate triangular, with appendage; flagellum short and trilobed; ring sclerite short and thick-walled, with sharply bent & twisted appendage; median sclerite strongly folded but not completely split.

Female (Fig. 23G). Spermathecal sclerite large and broad but weakly sclerotised; spermatheca C-shaped, gradually contracted to apex, with large median window.

DISTRIBUTION AND BIOLOGY (Fig. 29). Common in rainforest and vine-thicket at Iron and McIlwraith Ranges, Cape York Peninsula. Matthews (1974) noted that it was a nocturnal ball-roller in closed forest.

Temnoplectron diversicolle Blackburn
(Figs 1C, 3F, 4E, 8E, 15E, 19F, 22B, 23F, 24H, 29)

Temnoplectron diversicolle Blackburn, 1894: 204; Paulian, 1934: 285; Matthews, 1974: 154; Cassis & Weir, 1992: 170.

TYPE. Holotype, ♀ 'type/ 5215 T Nqu/ Temnoplectron diversicolle Blackb.' (BMNH). Redescribed by Matthews (1974), re-examined.

MATERIAL. (80) QUEENSLAND (localities only): McIvor R crossing (ANIC, DPIM, QM); Mt Webb NP (ANIC, DPIM, QM); 3km NE Mt Webb (ANIC).

DESCRIPTION (male). *Colour*. Black, elytra dark bronze-green and appendages reddish-brown.

Length. 6.0-6.5mm, body more elongate and less convex than *T. cooki* (Fig. 1C), length:width ratio 1.40-1.65.

Head (Fig. 3F). Lemon-shaped, lateral corners angulate to rounded, anterior margin slightly nicked at frontoclypeal junction then evenly shallowly curved to median teeth; dull, finely and sparsely punctured, disc more finely punctured and microreticulate than base; eyes moderately small, interocular ratio 8-9; first segment labial palp 1-1.3 × length second.

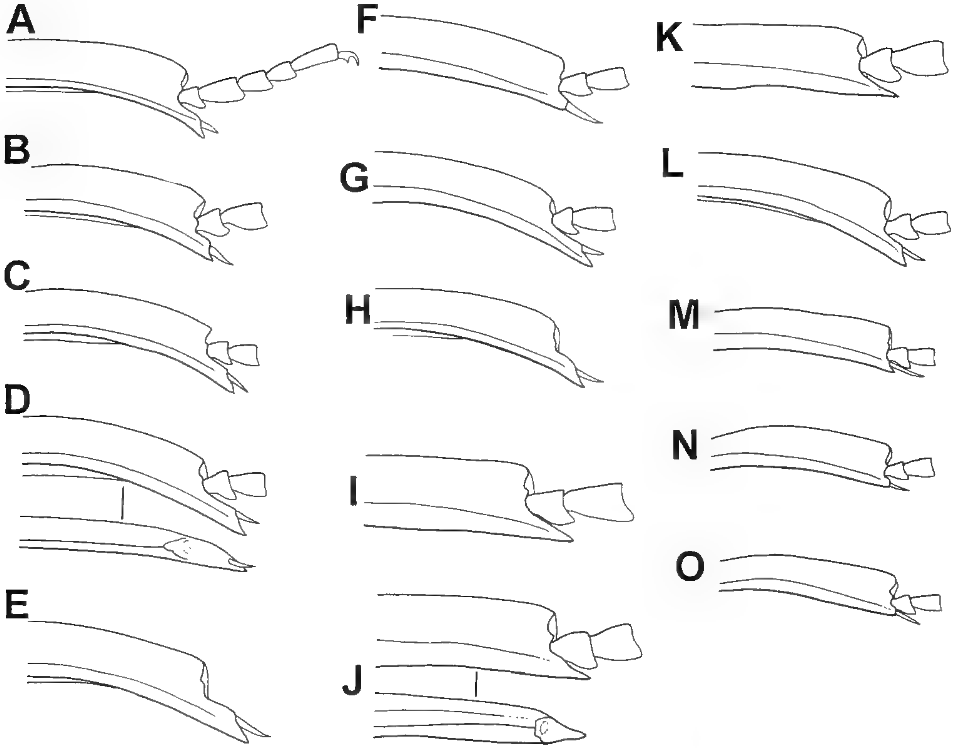

FIG. 13. *Temnoplectron* species, apices hind tibiae and first two hind tarsi, ♂ unless otherwise indicated; A, *aeneolum* Lansberge; B, *wareo* sp. nov.; C, *disruptum* Matthews; D, *aeneopiceum* Matthews (Paluma); E, *aeneopiceum* (Cardwell Range); F, *aeneopiceum*, ♀ (Cardwell Range); G, *subvolitans* Matthews (Mt Spurgeon); H, *subvolitans* (Bartle Frere); I, *atropolitum* Gillet; J, *atropolitum* Gillet (Adelbert Ra.); K, *atropolitum* Gillet; L, *finnigani* sp. nov.; M, *involucre* Matthews; N, *lewisense* sp. nov.; O, *monteithi* sp. nov. All to same scale.

Thorax (Figs 4E, 8E, 15E). Pronotum parallel-sided to apical third, without or with shallow median depression, basal margin evenly curved; lateral margin of pronotum effaced for middle 0.3-0.5; pronotal disc shining, finely and sparsely punctured and obscurely microsculptured, towards sides dull, more strongly microreticulate and less obviously punctate; hypomeral stria shallow, obliquely angled, hypomeral ratio 0.15-0.2; sides elytra evenly rounded; basal half elytra shining, finely punctured and feebly microreticulate, apical half duller, feebly punctured and strongly microreticulate; striae 1-7 feebly impressed, 7 only in basal half; stria 1 with punctures scattered throughout length, not apically deepened; stria 8 absent or present only on second quarter of elytra; stria 9 deep, abbreviated by 1.5-2× length mesepimeron; stria 10 deep, reduced by epimeron length; base of epipleuron not constricted; wing reduced to narrow unfolded strap but with at least 5 veins, 3/4 length of elytron; meso-metasternal margin raised but without or with minute median triangular tubercle; median lobe metasternum finely and sparsely punctured and margins triangularly expanded at corners, posterior of metasternum strongly and closely punctate; outer margin fore tibia with acute major teeth and 2-6 convex minor teeth between these, inner margin almost straight; mid femur elongate-ovate; hind femur with complete dorsal and ventral margins (ridges), almost parallel-sided but broadest c.1/3 from apex of trochanter; hind tibia almost evenly curved externally, with slight bulge 1/3 from apex on internal margin; apex of hind tibia produced, short spine 1.5× length first tarsal segment, pointed in dorsal view, with large subapical spur; tibial spine ratio 1-1.25; hind tarsi 0.25× length of hind tibia; hind tarsal segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19F, 22B). Suture between last two ventrites not or weakly grooved, without row of punctures; basal margin of pygidium evenly curved, without median prominence; parameres without apical setal fringe, almost symmetrical but left smaller than right, both excavate at base of venter, apically truncate and incurved as rounded lobes; endophallus: ridges of flagellum not strongly lobed; basal sclerite folded and irregular, with appendage; ring sclerite with thick ring and curved appendage; median sclerite roughly triangular with median split.

Female (Figs 23E, 24H). Spermathecal sclerite reduced to quadrate area of sclerotisation around base of duct; spermatheca C-shaped with cylindrical base, medial constriction and gradually contracted apex.

DISTRIBUTION AND BIOLOGY (Fig. 29). Known only from a small area of lowland rainforest 45km north of Cooktown (the type locality). It is the only species of *Temnoplectron* confined to lowland rainforest.

Temnoplectron finnigani sp. nov.
(Figs 3O, 4G, 5E, 10A, 12G, 13L, 16D, 18A, 22D, 23J, 30)

Temnoplectron subvolitans Matthews, 1974: 158, partim.

ETYMOLOGY. Named from Mount Finnigan, at the core of this species' range.

TYPE. Holotype, ♂, QMT70079: 'NEQ 15°49S 145°17E Mt Finnigan summit, RF, 1100m, 20-21 Nov 1998, dung trap 8pm-8am, G. Monteith' (QM)

PARATYPES. (269) QUEENSLAND: 1, Big Tbld, 15°43S 145°17E, 700m, 19-20.xii.1990, ANZSES expedition (QM); 4, ditto, except: small pitfalls, 20-21.xii.1990 (QM); 2, Mt Finnigan, via Helenvale, 300-610m, 20-27.vii.1974, GM & DC (QM); 2, ditto, except: 760m (QM); 1, ditto, except: no altitude, 21.iv.1982, GM, DY & DC (QM); 23, ditto, except: rainforest, 850-1100m, 19-22.iv.1982 (ANIC, QM); 13, ditto, except: pitfall traps, 1050m (QM); 1, ditto, except: pitfall traps, 850-950m, 3-5.xii.1990, DC, GT & LR (QM); 2, ditto, except: 1050m (QM); 12, ditto, except: summit, 1050m, GM, GT, DC, Sheridan & LR (QM); 6, ditto, except: 850-950m (QM); 23, ditto, except: summit, 1100m, 28-30.xi.1985, GM, DC & LR (QM); 8, ditto, except: pitfall traps, rainforest, GM & DC (QM); 4, ditto, except: dung traps (QM); 47, ditto, except: 15°49S 145°17E, 20-22.xi.1998, GM, Bouchard & O'Toole (QM); 1, ditto, except: 15°48S 145°17E, pitfalls, 1060m, 4.xii.1990-17.i.1991, QM & ANZSES (QM); 1, ditto, except: 1050m (QM); 3, ditto, except: 1080m (QM); 1, ditto, except: flight intercept, 940m (QM); 1, Mt Finnigan east shoulder, 950m, 15°48S 145°18E, 14.i.1991, ANZSES expedition (QM); 57, Mt Hartley, 15°46S 145°19E, summit, pitfall traps, 750m, 8.xi.1995-16.i.1996, GM, DC & LR (QM); 2, ditto, except: 790m (QM); 17, ditto, intercept trap, (QM); 20, ditto, except: SW slope, 750m (QM); 15, ditto, except: pitfall traps (QM); 5, 2.5km SW Mt Hartley, 35km S Cooktown, 23-24.iv.1982, GM, DY & DC (QM); 5, ditto, except: rainforest pitfall traps (QM).

DESCRIPTION (male). *Colour.* Black, elytra dark bronze-green, appendages and often venter reddish-brown.

Length. 4.5-5.5mm.

Head (Fig. 3O). Lemon-shaped, genal angles evenly curved, anterior margin evenly curved from genal angles to median teeth; head finely and sparsely punctured, with patches of larger punctures around eyes and at base of clypeus, dull and microreticulate; eyes small, interocular ratio 7-8.5; first segment of labial palpi 1-1.2 × length second.

Thorax (Figs 4G, 5E, 10A, 12G, 13L). Pronotum evenly convex, with shining disc or finely microreticulate throughout, sides of disc strongly and closely punctured; lateral border of pronotum complete; hypomeral ratio 0.25-0.5, stria slightly convergent with side of pronotum; sides of elytra evenly curved from base to apex; elytra entirely microreticulate or disc shining without microsculpture, intervals finely or obscurely punctured; striae 1-7 faint, impunctate and feebly impressed; stria 8 present as an impressed line (may be broken) on second quarter of elytra; stria 9 deeply grooved, with 2-3 shallow impressions at apex, abbreviated by 2-3 × length mesepimeron; stria 10 abbreviated at length of mesepimeron from base; base of upper margin of epipleuron not depressed; wing reduced to narrow unfolded strip, 1/2 length of elytra; meso-metasternal border with small transverse median tubercle; metasternal anterior lobe finely and sparsely punctured, with margins triangularly expanded in corners; outer margin of fore tibia with large acute major teeth separated by 2-3 truncate minor teeth, inner margin almost straight; mid femur elongate-ovate; hind femora with complete dorsal and ventral margins (ridges), almost parallel-sided but broadest c.1/3 from apex of trochanter; hind tibia almost evenly curved externally, with slight bulge 1/3 from apex on internal margin, apical spine about length of tarsal segment 1, tibial spine ratio 0.75, with small articulated spur shorter than first tarsal segment; hind tarsi c.1/3 length of hind tibia; hind tarsal segment 1 triangular (ventrally lobed), 2, 3

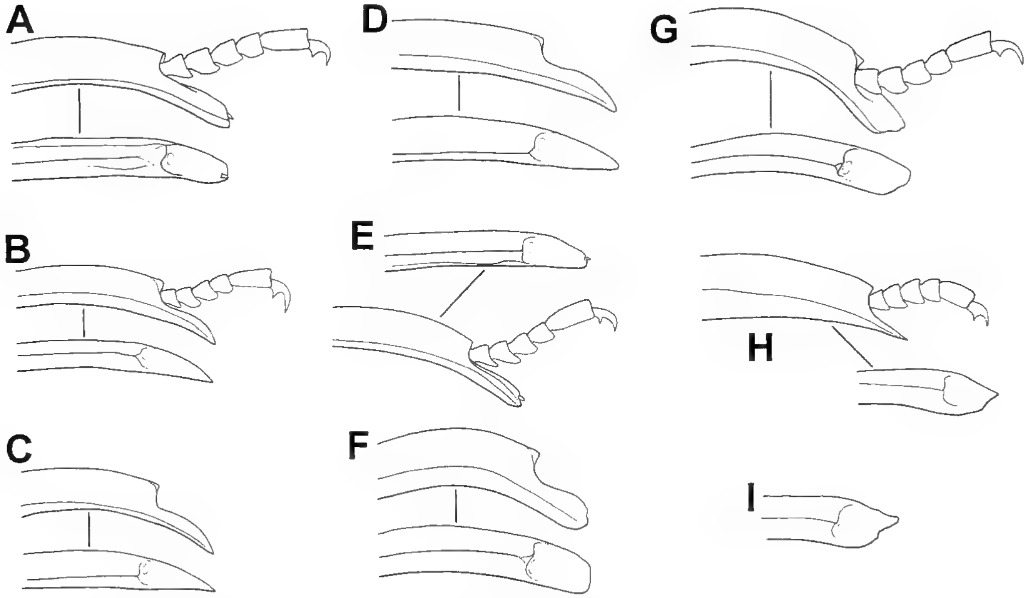

FIG. 14. *Temnoplectron* species, apices ♂ hind tibiae and tarsi, *rotundum* species group; A, *bornemisszai* Matthews; B, *boucomonti* Paulian; C, *boucomonti*; D, *boucomonti*; E, *laeve* (Laporte); F, *major* Paulian; G, *major*; H, *rotundum* Westwood (worn); I, *rotundum* (fresh). All to same scale.

and 4 elongate-rectangular, decreasing in length, 5 slightly shorter than segments 3+4.

Abdomen (Figs 16D, 18A, 22D). Last two ventrites without deep punctate groove between; basal margin of pygidium with median convexity; parameres almost identical to each other, sinusoidal, excavated at base of venter, blunt tipped in profile but with minute subapical tooth, only slightly incurved at apices, each with apico-ventral row of setae; endophallus: ridges of flagellum strongly lobed and splayed at base; basal sclerite solid, roughly pyramidal with irregular lobes; ring sclerite distorted, ring obscure with appendage drawn out into twisted irregular cylinder; median sclerite two sets of angular lobes with median split.

Female (Fig. 23J). Spur of fore tibia evenly attenuated to sharp curved apex; hind tibia without apical spine; genitalia: spermathecal sclerite broad and flat, transverse; spermathecal duct massive for two basal loops; spermatheca C-shaped with hooked tip and slightly swollen base.

REMARKS. The basal swelling of the pygidium easily distinguishes this species from other small flightless *Temnoplectron*.

DISTRIBUTION AND BIOLOGY (Fig. 30).A common flightless species of rainforest in a small area of upland between the Bloomfield and Annan Rivers, north Queensland.

Temnoplectron involucre Matthews
(Figs 3L, 10I, 13M, 18B, 22E, 24G, 29)

Temnoplectron involucre Matthews, 1974: 156; Cassis & Weir, 1992: 171.

TYPE. Holotype seen, in ANIC.

MATERIAL. (189, including holotype) QUEENSLAND (localities only): Bluewater Ra, N and S ends (JCU, QM); Mt Halifax (JCU, QM); Mt Spec (holotype and paratypes, ANIC, BMNH, DPIM, JCU); 2mi W Mt Spec (DPIM); Paluma (JCU, QM); 2.7mi W Paluma (BMNH); 6-7km WNW Paluma (ANIC, DPIM); 5-6km (3.6-4mi) W Paluma (ANIC, BMNH); 4.5km W Paluma (ANIC, BMNH); 9km W Paluma (ANIC, BMNH); 8mi W Paluma (ANIC); Paluma Dam Rd (QM); Uncle Tom's Cabin, Paluma (ANIC).

DESCRIPTION (male). *Colour.* Black, elytra dark-greenish (more obvious at apex), appendages reddish-brown.

Length. 3.5-5mm.

Head (Fig. 3L). Lemon-shaped; head finely and sparsely punctured to almost impunctate, dull and microreticulate throughout or basal third shining; anterior margin of frontoclypeus evenly curved from genal angle to median teeth; dorsal portion of eyes small, broadest near base, interocular ratio 7-8; lengths of first two segments of labial palpi approximately equal.

Thorax (Figs 10I, 13M). Pronotum evenly convex, shining, without microsculpture or rarely sides microreticulate, finely and sparsely punctured, or rarely strongly and densely punctured at sides of disc; lateral margin pronotum complete; hypomeral ratio 0.2-0.4, stria convergent with sides of pronotum; disc of elytra (at least basal third of intervals 1-3) not microsculptured, shining, or rarely microreticulate; elytral intervals finely but distinctly punctured; striae 1-7 feebly impressed and impunctate throughout; elytral stria 8 absent or reduced to a few pits; stria 9 abbreviated at base by 1.5-2.5× length of mesepimeron; base of upper margin of epipleuron not depressed; wings reduced to narrow unfolded strip, c.0.5 elytron length; meso-metasternal margin with small transverse median tubercle; anterior process of metasternum shining, finely and sparsely to densely punctured, margins triangularly expanded at anterior corners; outer margin fore tibia with acute major teeth, separated by 3-5 sharp or convex minor teeth; inner margin fore tibia almost straight, not excavate in basal half; mid and hind femur elongate-ovate; hind tibia with extremely short and blunt apical spine, tibial spine ratio 0.3-0.4, with long apical articulated spur, longer than basal tarsal segment; hind tarsi 0.4 × length hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 18B, 22E). Last two ventrites not separated by deep punctate groove; pygidium with smoothly curved basal margin; parameres without apical setal fringe, asymmetric, left paramere sinusoidal, with blunt rounded apex, not incurved; right paramere similar but with apex projecting as a short flat incurved plate, giving pointed profile; endophallus: ridges of flagellum strongly lobed and splayed at base; basal sclerite solid, roughly cylindrical with irregular lobes; ring sclerite distorted, ring obscure with appendage drawn out into twisted irregular cylinder; median sclerite two sets of angular lobes with median split.

Female (Fig. 24G). Fore tibial spur evenly attenuated to sharp curved apex; genitalia: spermathecal sclerite distinct, a transverse and narrow ridge; spermatheca C-shaped, gradually attenuated from slightly bulbous base to apex.

DISTRIBUTION AND BIOLOGY (Fig. 29). Confined to rainforest and wet sclerophyll forest in the Paluma and Bluewater Ranges, where it is abundant. Present all year, but most active or abundant from December to July (Hill, 1993). *Temnoplectron involucre* occurs at wallaby, pig and human dung and is a ball-roller (Rortais, 1999).

Temnoplectron laeve (Laporte)
(Figs 2F-G, 4D, 7D, 11E, 11I, 14E, 16B, 17E-F, 20E, 27, 32)

Hyboma laeve Laporte, 1840, 72.
Temnoplectron laeve (Laporte): Paulian, 1938; 242. Matthews, 1974 150; Cassis & Weir, 1992, 171.
Temnoplectron laeve Waterhouse, 1874: 175; Paulian, 1934 286; Paulian, 1938: 242 (synonymy)

TYPES. Holotype of *Temnoplectron laeve* Waterhouse: female: /Queensland /Type /Temnoplectron laeve Waterh. Type /. Type of *Hyboma laeve* Laporte not examined and apparently lost (see below)

MATERIAL. (301; data reduced to locality, altitude, date, collector) QUEENSLAND: 1, Bluewater Ra, 50km WNW Townsville, 700m, 6-9.xii.1986, GM, GT & Hamlet (QM); 20, Brandy Ck, 150m, 20.xi.1992-14.iv.1993, GM & DC (QM); 2, Little Crystal Ck, 30.v.1969, DIC, RH (ANIC); 15, Mt Blackwood, 590m, 18.xi.1992-14.iv.1993, GM & DC (QM); 39, 0.5km NW Mt Dryander, 650m, 21.xi.1992-15.iv.1993, GM & DC (QM); 4, Mt Halifax, 13-19.xi.1991 (JCU); 16, Mt Halifax, summit, 21.iii-10.v.1991, DC, C. Hill (DPIM, QM), 7, ditto, except 1050m, 19-21.iii.1991, GM, DC (QM); 13, ditto, except i-20.iii.1991, A, Graham (QM); 5, ditto, except SE Ridge, 905m (QM); 3, ditto, except 4.xii.1990-8.i.1991 (QM); 22, Mt Hayward, 350m, 20.xi.1992- 14.iv.1993, GM & DC (QM); 3, Mt Spec, 880m, 26.xii.1977, 9.iii-6.iv.1995, RS, M. Cermak (ANIC, DPIM, JCU); 22, 1.5km SW Mt Spurgeon, 1100m, 21.xii.1988-5.i.1989, GM, GT (QM); 7, 3km S Mt Spurgeon, 1100m, 19-22.xi.1997, DC (QM); 1, North Queensland (ANIC); 20, Paluma, 880m, 5.xi.1992, iii.1993, anon., M. Gray, A. Rortais (ANIC, JCU); 2, 5mi W Paluma, 24.iv.1969, GB, DIC (ANIC); 1, 3mi E Paluma, 14.v.1969, GB, RH (ANIC); 2, ditto, except 5mi E Paluma (ANIC); 1, Paluma Dam Rd, Mt Spec, 30.iii.1968, EM (ANIC); 1, ditto, except 850m, 17.xi-8.xii.1990, GM, JS (QM); 1, ditto except 720m, 8.xii.1990-5.ii.1991 (QM); 1, Pine Mt, 600m, 14.x-17.xii.1999, DIC (QM); 2, Shute Harbour, 20m, 4-5.iv.1997, GM (QM); 30, Stony Ck, 260-280m, 19-20.iv.1998, 4.x.1999-23.iii.2000, DIC, GSM (QM); 43, Upper Cameron Ck, 6km NW Koumala, 100m, 18-19.iv.1999, 1.x.1999-23.iii.2000, GSM, DIC, CB, Evans (QM); 7, Upper East Funnel Ck, 230-250m, 16.xi.1992-15.iv.1993, GM & DC (QM); 9, Upper Hall Ck, via Carmila, 320m, 4.xii.1996-7.iv.1997, DC (QM); 1, Windsor Tbld, i.1981, I. Fanning (QM).

DESCRIPTION (male). *Colour.* Black, with reddish-brown head appendages and tarsi.

Length. 9-11.5mm.

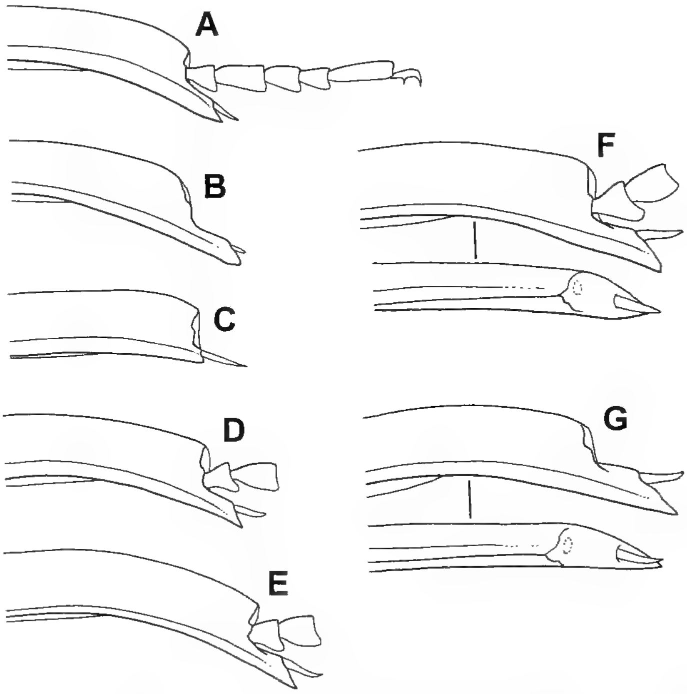

FIG. 15. *Temnoplectron* species, apices hind tibiae and hind tarsi, ♂ unless othewise indicated; A, *politulum* Macleay; B, *politulum* (worn); C, *politulum*, ♀; D, *reyi* Paulian; E, *diversicolle* Blackburn; F, *cooki* sp. nov. (Mt Spurgeon); G, *cooki* (Mt Haig). All to same scale.

Head (Fig. 2F-G). Lemon-shaped with rounded genal angles, anterior margin of frontoclypeus almost evenly curved from genal angles to median teeth, without swelling or excavation beside median teeth, but with small incision at junction of frons and clypeus; eyes large, interocular ratio 4-5; frontoclypeus dull, microreticulate, moderately punctured, becoming rugose towards anterior; first segment of labial palpi much broader than and 1.3-1.5 × longer than second segment.

Thorax (Figs 4D, 7D, 11E, 11I, 14E). Pronotum not anteriorly depressed; pronotal disc finely punctured, shining, not or shallowly microreticulate; elytra dull, strongly microreticulate and finely or obscurely punctured; striae 1-7 impunctate or almost so, without foveolate punctures, not deepened in apical half; hypomeral stria short, ratio 0.35-0.45; elytra not or feebly swollen at base of 5th interval; elytral stria 7 extremely faint; stria 8 present almost to elytral base, abbreviated by 0.3-0.5 × length mesepimeron; stria 9 separated from base by length of mesepimeron; stria 10 similar to stria 8, abbreviated at base by about 0.5 × length mesepimeron; base of epimeron not constricted; macropterous; meso-metasternal suture without median tubercle; metasternal anterior lobe with narrow margins; outer margin fore tibia with short and obtuse major teeth, separated by 1-2 convex minor teeth; inner margin fore tibia abruptly emarginate 0.3-0.5 from base, or angulate, not obviously emarginate; mid femur with broad blunt ventral lobe about 2/3 from apex of trochanter; hind femur relatively short and broad, ratio of length from apex of trochanter to greatest width = 5/2, greatest width about half length from apex of trochanter; hind tibia relatively short and curved, compared with *T. boucomonti*, curvature strongest about 1/3 and 2/3 from base; posterior tibial spine elongate, tibial spine ratio 1.5-2, thick and blunt, about equal to segments 1-3 of tarsi, with minute apical articulated spur; hind tarsi relatively short, combined length c.0.2 × length hind tibia; hind tarsal segments 1-3 ventrally lobed, 4 elongate rectangular, 1-4 approximately equal in length, 5 = segments 3+4.

Abdomen (Figs 16B, 17E-F, 20E). Last two ventrites not separated by deep punctate groove; basal margin of pygidium with rounded median tubercle; parameres without apical setal fringes, almost symmetrical, narrow and dorsally excised, with bluntly rounded apices and short flat apicoventral lobes, but left thicker than right, with smaller apical lobe; endophallus: ridges of flagellum strongly lobed; basal sclerite roughly quadrate, opaque and feebly folded; ring sclerite with narrow thick ring and curved appendage; median sclerite irregular, strongly folded; apex of endophallus with patch of spinules.

Female (Fig. 11F). As above, except: mid femur broadest apically, with slight anterior expansion of ventral edge; spermathecal sclerite broad, straight sided, but weakly sclerotised, enclosing vagina, width about 7 times length; spermatheca constricted just before middle bend, therefore base bulbous, apex relatively thin.

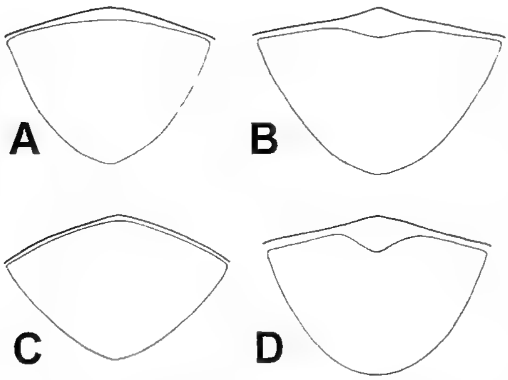

FIG. 16. *Temnoplectron* species, ♂ pygidium; A, *boucomonti* Paulian; B, *laeve* (Laporte); C, *cooki* sp. nov.; D, *finnigani* sp. nov. Not to scale.

REMARKS. Confused with *T. boucomonti* (as *T. laevigatum*) by Matthews (1974), which is separated by: eyes separated by 5-6 eye-widths; hypomeron ratio >0.8; elytral striae slightly deeper and 8 and 9 separated from base of elytra by 2× length mesepimeron; male hind femur relatively long and narrow, ratio of length from apex of trochanter to greatest width = 3/1, and hind tibia longer; left paramere without apicoventral tooth; vaginal plate without well-defined transverse sclerite; spermatheca with sinuate bulbous base.

The type of *T. laeve* Laporte was borrowed from the Hope Department Collection, Oxford University by Paulian in the 1930s (Paulian, 1938) but is no longer present in that collection (G. McGavin, pers. com.) and is probably lost. The above synonymy is therefore possibly erroneous, but follows accepted practice (Matthews, 1974, Cassis & Weir, 1992).

DISTRIBUTION AND BIOLOGY (Figs 27, 32). Common in rainforest and wet sclerophyll on isolated ranges in northern Queensland: Windsor Tableland, Carbine Tableland, Paluma-Bluewater Range, Dryander-Conway Range, Mount Blackwood and the ranges south of Sarina to near Carmila. In the northern localities (mapped in Fig. 27) it is strictly montane (700-1200m) and apparently confined to wet sclerophyll forest, but further south occurs in rainforests down to sea-level and is occasionally taken in drier forest. It is most abundant during the wet season and rare or not active during the dry season (Hill, 1993).

Temnoplectron lewisense sp. nov.
(Figs 1E, 3M, 10F-H, 13N, 18E, 22F, 23K, 30)

ETYMOLOGY. Named from Mount Lewis, at the core of this species' range.

MATERIAL. Holotype, ♂, QMT59987: 'NEQ 16°34S 145°16E, Mt Lewis Rd, Windmill Ck, 18 Nov 1997, GM & DC, 900m, rainforest pitfall' (QM). PARATYPES. (371) QUEENSLAND: 25, Black Mt, 17km ESE Julatten, 800-1000m, 29-30.iv.1982, GM, DY & DC (QM); 1, ditto, except: pyrethrum knockdown (QM); 6, Carbine Tbld, above Fern Patch, Devils Thumb, pitfall traps, 1050m, 26-27.xi.1990, GM & HJ (QM); 6, Devils Thumb, area, 10km NW Mossman, 1000-1180m, 9-10.x.1982, GM, DY, GT (QM); 2, ditto, 12km NW Mossman, pitfalls, 1000m, 26-27.xii.1989, ANZSES (QM); 4, ditto, except: 16°23S 145°16E, 1100m, 30.vi-1.vii.1997, DC (QM); 4, ditto, except 1160m (QM); 1, Karnak-Devils Thumb, 8-12km NW Mossman, pitfall, 1080m, 26.xii.1989-15.i.1990, ANZSES (QM); 4, ditto, except: 1120m (QM); 2, ditto, except: 1160m (QM); 3, ditto, except: 1100m (QM); 4, ditto, except: Devils Thumb-Pauls Luck, 1240m, 27.xii.1989-15.i.1990 (QM); 2, ditto, except: 1300m (QM); 2, 12km WNW Mossman, Head of Roots Ck, pitfalls, 1200m, 28.xii.1989-11.i.1990, ANZSES (QM); 2, 11km NW Mossman, nr Plane Crash, pitfalls, 1200m, 10.i.1990, ANZSES (QM); 1, ditto, except: 1330m, 27-28.xi.1990, GM, GT, DC, Sheridan & HJ (QM); 1, Mossman Bluff track, 5-10km W Mossman, intercept, 1260m, 17-31.xii.1988, GM & GT (QM); 14, Mossman Bluff track, 5-10km W Mossman, pitfall, 1300m, 1-17.i.1989, GM & GT (QM); 2, ditto, except: intercept (QM); 4, ditto, except: pitfall, 20.xii-15.i.1990 (QM); 3, ditto, except: 1260m (QM); 1, ditto, except: intercept, 1300m (QM); 1, ditto, except: 1260m (QM); 9, ditto, except: 17-31.xii.1988 (QM); 6, ditto, except: pitfall (QM); 2, ditto, except: pitfall, 1180m (QM); 9, Mt Demi, north peak, 16°30S 145°19E, pitfall traps, 1050m, 17.xii.1995-25.i.1996, GM, GT & Ford (QM); 11, ditto, except: flight intercept (QM); 3, ditto, except: summit, 1100m (QM); 40, ditto, except, pitfall traps (QM); 9, ditto, except: 16-17.xii.1995, GM & GT (QM); 9, Mt Lewis, pitfalls, i-iii.1988, G. Wood (QM); 1, Mt Lewis, 970m, 29.iv.1973, RT (ANIC); 2, ditto, except: dung trap, 14-18.xii.1986, HAH (DPIM); 3, Mt Lewis, 16°35S 145°17E, berlesate, rainforest, 960m, 30.x.1976, RT & TW (ANIC); 1, Mt Lewis, 20km S Mossman, 1000m, 10.vii.1982, SJP (ANIC); 2, ditto, except 1.viii.1982 (ANIC); 7, Mt Lewis, 8km NW Julatten, 8.i-2.ii.1987, RS & H. Howden (ANIC); 3, 2km ESE Mt Lewis, 16°35S 145°18E, rainforest pitfall, 820m, 18.xi.1997-7.ii.1998, GM & DC (QM); 14, Mt Lewis Rd, Julatten, rainforest, 1.xii.1975, 30-31.x.1976, RS, AWH (ANIC, DPIM); 5, ditto, except: rainforest intercept, 1000m, 11.xi-25.xii.1987 (ANIC); 4, Mt Lewis Rd, 16°34S 145°17E, rainforest by Rd, FIT, c750m, 4.iv.1997, K. Abbott (ANIC); 4, 11km up Mt Lewis Rd from highway, pitfall, 1000m, 18.xii-13.i.1990, GM & GT (QM); 1, ditto, except: 16km, 950m (QM); 1, ditto, except: Old Barracks area, 1000m, 13.i.1990, ANZSES (QM); 8, 11km up Mt Lewis Rd, flight intercept, 9-23.xi.1982, 26.xii.1986-2.ii.1987,

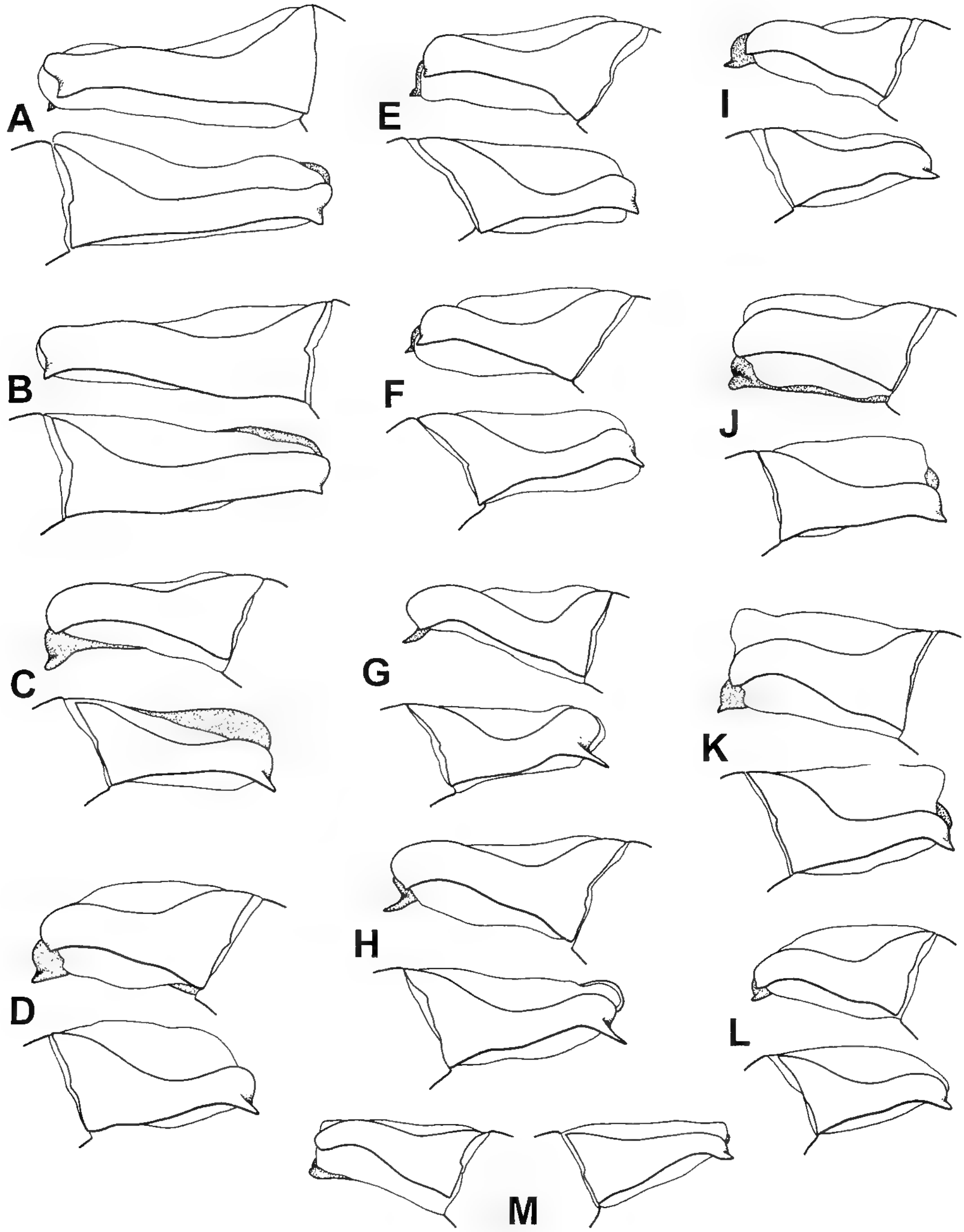

FIG. 17. *Temnoplectron* species, aedeagal parameres, left (above), right (below); A, *bornemisszai* Matthews (Yungaburra); B, *bornemisszai* (Windsor Tbld); C, *boucomonti* Paulian (PNG); D, *boucomonti* (Adelaide R.; holotype *laevigatum* Matthews); E, *laeve* (Laporte) (Mt Halifax); F, *laeve* (Mt Spurgeon); G, *major* Paulian (PNG); H, *major* (Forty Mile Scrub); I, *rotundum* Westwood (Yirrkala); J, *rotundum* (Mt Tozer); K, *atropolitum* Gillet (Dormanpadbivak); L, *atropolitum* Gillet (Adelbert Ra.); M, *atropolitum* Gillet (Mt Hagen). All to same scale.

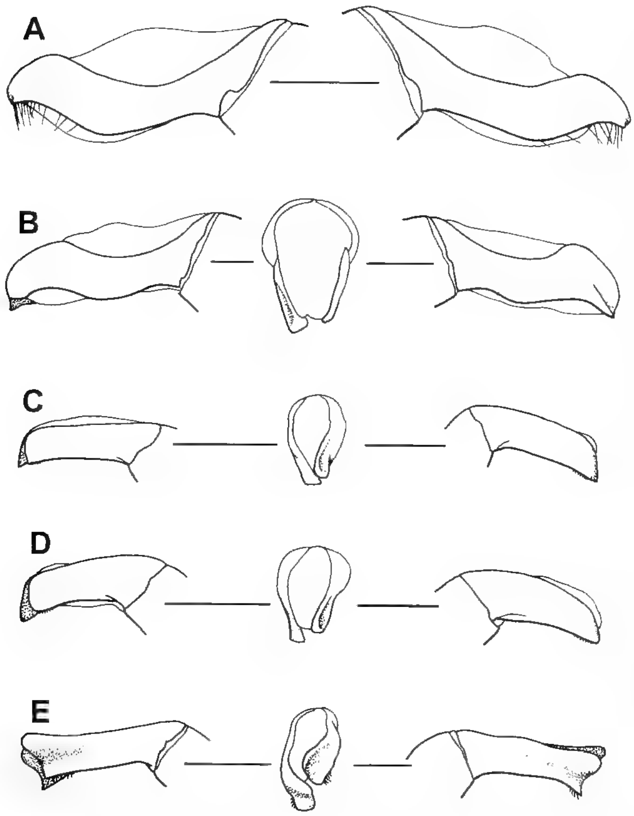

FIG. 18. *Temnoplectron* species, aedeagal parameres, left, apical, right; A, *finnigani* sp. nov.; 160, *involucre* Matthews; 161, *monteithi* sp. nov. (Mt Halcyon); 162, *monteithi* sp. nov. (Thornton Peak); 163, *lewisense* sp. nov. All to same scale.

11.xi-25.xii.1987, Morgan, JDB, AWH, Howden & RS (ANIC, DPIM); 10, 13km up Mt Lewis Rd, via Julatten, human dung trap, 29.iv-2.v.1976, RS (DPIM); 3, 18km up Mt Lewis Rd via Julatten, intercept trap, 9.xi-22.xii.1982, Morgan, JDB, RS (DPIM); 6, 22km up Mt Lewis Rd, 16°33S 145°17E, rainforest pitfall, 1000m, 29.xi.1997-7.ii.1998, GM & DC (QM); 5, 29km up Mt Lewis Rd, 16°31S 145°16E, rainforest pitfall, 1210m, 18.xi.1997-7.ii.1998, GM & DC (QM); 1, Mt Lewis, 17km W Julatten, 12.xii.1982, JT (ANIC); 10, Mt Spurgeon, 16°27S 145°12E, tall primary rainforest by track, human dung trap, 1150m, 19-22.xi.1997, CR (ANIC); 11, ditto, except: 2km SSE Mt Spurgeon, 1100m, GM & CR (QM); 1, ditto, except: GM, DC & CB (QM); 2, ditto, except: 3km S, 16°27S 145°11E, dung traps, open forest, DC (QM); 9, ditto, except: tall primary wet sclerophyll by track, bandicoot (?) dung (fruit), 1150m, CR (ANIC); 1, 2km SE Mt Spurgeon, rainforest pitfalls, 1100m, 20-21.xii.1988, GM & GT (QM); 1, ditto, except: 20.xii.1988-4.i.1989 (QM); 2, ditto, except: 16°27S 145°12E, 13-14.x.1991, GM, HJ & DC (QM); 1, 3.5km NNE Mt Spurgeon, 16°24S 145°13E, 1350m, 15-20.x.1991, GM, HJ, DC & LR (QM); 1, ditto, except: 2.5km NE, 16°25S, 1200m (QM); 2, ditto, except: 4km NNE, 1250-1300m (QM); 2, 7km N Mt Spurgeon, 16°22S 145°13E, 1200-1250m, 17-19.x.1991, GM, HJ, DC & LR (QM); 1, Pauls Luck, Carbine Tbld, pitfall traps, 1100m, 28-30.xi.1990, GM, HJ & DC (QM); 2, Pauls Luck, Platypus Ck, 13km W Mossman, pitfall traps, 1100m, 1-16.i.1990, ANZSES (QM); 2, ditto, except: 16°26S 145°14E, 25-26.vi.1997, DC (QM); 20, Roots/Saltwater Cks Divide, via Mossman, 16°25S 145°16E, dung baited pitfall trap, 1200m, 27-28.vi.1997, DC (QM); 17, Upper High Falls Ck, 16°24S 145°17E, flight intercept trap, 1000m, 25.i-12.ii.1996, R. Wertz (QM); 9, Upper Whitehall Gully, 16°25S 145°15E, dung baited pitfall, 1240m, 26-27.vi.1997, DC (QM); 7, Windmill Ck, Mt Lewis Rd, 16°34S 145°16E, rainforest pitfall, 900m, 18.xi.1997-7.ii.1998, GM & DC (QM).

DESCRIPTION (male). *Colour.* Black with brassy-green elytra, reddish-brown appendages and often brown pygidium and elytral apex.

Length. 3.5-5mm.

Head (Fig. 3M). Upper surface dull, entirely microreticulate, or basal quarter shining and not or shallowly microreticulate, or only apical quarter dull and microreticulate; fronto-clypeus moderately strongly punctured, at least in basal half; lemon-shaped, genal angles rounded, anterior margin evenly curved or almost straight to prominent median tubercles; dorsal portion of eyes moderately small, broadest near middle, interocular ratio 8-10; first segment of labial palpi about equal to second.

Thorax (Figs 10F-G, 13N). Disc of pronotum not depressed, shining, not or feebly microreticulate, sides dull and microreticulate, or rarely shining (most specimens from Mt Demi); disc of pronotum strongly and closely to finely punctured; basal 2/3 of pronotal sides almost straight, basal margin evenly curved; circular depression at about 1/2 length sides of pronotum; lateral margins of pronotum completely bordered or middle 0.2-0.3 effaced; hypomeral ratio 0.2-0.5, stria not convergent with sides of pronotum; elytral sides evenly convex; elytra densely microreticulate, intervals finely punctured; striae 1-7 faint and impunctate, except stria 5 usually deeper on disc and partially finely ridged (not

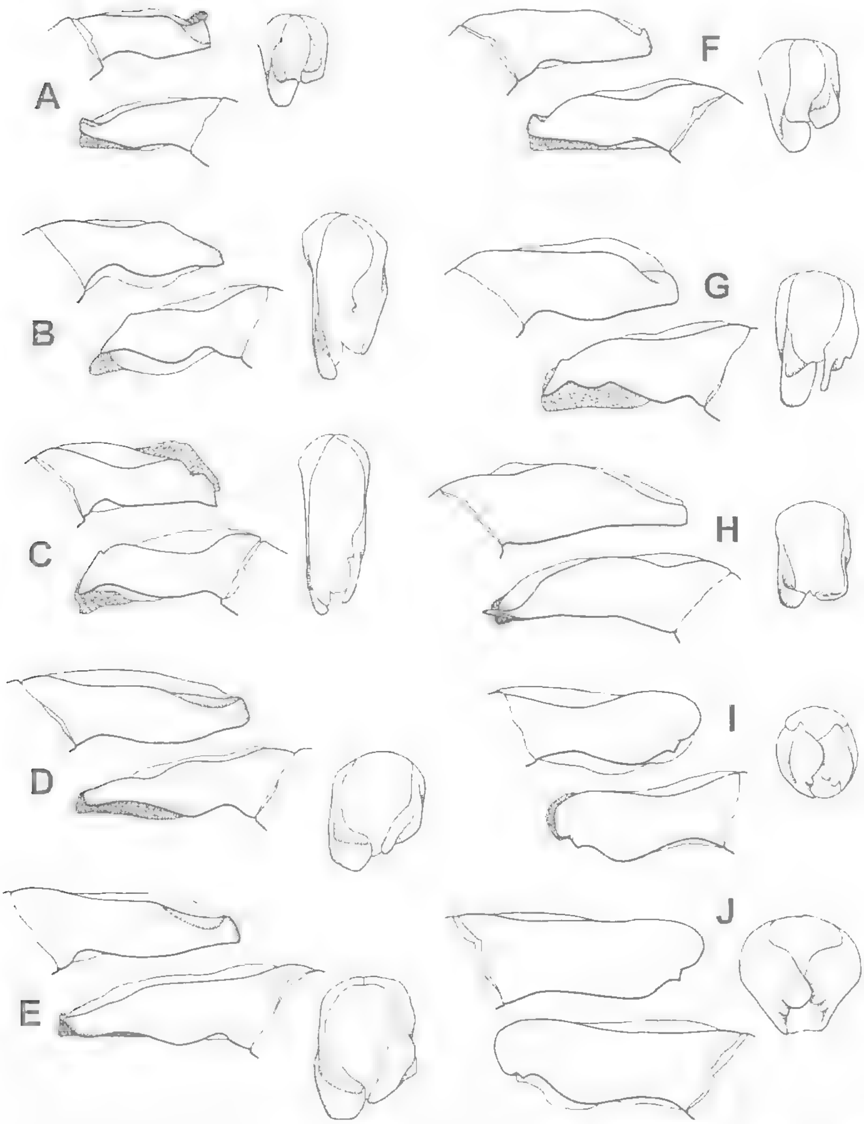

FIG. 19. *Temnoplectron* species, aedeagal parameres, left, apical, right; A, *disruptum* Matthews; B, *aeneopiceum* Matthews; C, *subvolitans* Matthews (Millaa Millaa Falls); D, *cooki* sp. nov. (Mt Tiptree); E, *cooki* (Mt Spurgeon); F, *diversicolle* Blackburn; G, *politulum* Macleay; H, *reyi* Paulian; I, *wareo* sp. nov.; J, *aeneolum* Lansberge. Not to scale.

small specimens from Devils Thumb); stria 8 absent; stria 9 abbreviated, separated from elytral base by 1.5-2× length mesepimeron; stria 9 deeply grooved, delineated by fine ridge, with at most a few foveolate punctures confined to apical fifth; stria 10 separated from base by about mesepimeron length; base of epipleural upper margin not depressed; wing reduced to minute unveined strap, 0.7mm long; metasternal median lobe usually strongly and moderately densely punctured (in parts interspaces 1-2 puncture diameters), more rarely finely and sparsely punctured; anterior of lobe separated from mid coxae by expanded triangular margins; middle of meso-metasternal border with small transverse tubercle; outer margin fore tibia with acute major teeth separated by 3-5 sharp or at least convex minor teeth, inner margin almost straight, not basally excavate; mid femur elongate-ovate; hind femur almost parallel-sided for most of length, without ventral lobe; hind tibia feebly curved, with short blunt apical lobe, tibial spine ratio 0.3-0.4, and prominent articulated spur about as long as first tarsal segment; hind tarsi long, combined length almost half length tibia; hind tarsal segment 1 triangular (ventrally lobed), 2 and 3 elongate rectangular, 4 quadrate and small (2/3 length 3), 5 = segments 3+4.

Abdomen (Figs 18E, 22F). Last two ventrites not separated by deep punctate groove; basal margin of pygidium evenly curved, without median tubercle; parameres similar shaped, right with sharper flatter basal lobe; each with concave apex, longitudinally concave in apical third, and short row of small setae on lower surface; endophallus: ridges of flagellum lobed and splayed at base; basal sclerite solid, a flattened cone; ring sclerite distorted, ring thick-walled with appendage drawn out laterally and twisted; median sclerite three convex lobes.

Female (Figs 10H, 23K). As above, except: apical spur of fore tibia evenly attenuated to curved tip; spermathecal plate with thin transverse well-defined sclerite, width about 9 × length, curved at sides and encircling spermathecal duct; spermatheca falcate, gradually narrowed to apex, relatively small and thin.

REMARKS. This small globular species may be confused with *T. monteithi*; but the structure of stria 9, the fore-tibial teeth and female fore-tibial spurs separates them fairly easily. It is similar to large species of *Lepanus* Balthasar in the field.

DISTRIBUTION AND BIOLOGY (Fig. 30). An abundant small flightless species confined to rainforest at relatively high elevations on the Carbine Tableland, north Queensland, with a single outlying population 20km to the southeast at Black Mountain.

Temnoplectron major Paulian
(Figs 2H, 7E-F, 11C, 11J, 12B, 14F-G, 17G-H, 20B, 28)

Temnoplectron major Paulian, 1985: 226.
Temnoplectron rotundum sensu Matthews, 1974: 152 partim, nec Westwood, 1841.

TYPE. Holotype not seen (in CMN), but topotypic material examined.

MATERIAL. (180, data reduced to locality, altitude, date, collector) AUSTRALIA: Queensland: 7, Andoom, 5-8.ii.1975, GM (QM); 1, Bamaga, 18-25.iii.1987, GM (QM); 1, Edungalba, x.1980, E. E. Adams (UQ); 54, Forty Mile Scrub [NP], 31.v.1972, 19-20.iv.1973, 7.i.1976, 23.ii.1988, 6.xi.1991, 1.x.1993, x.1993-i.1994, i.1994, DM, Hasenpusch, Lawless, GM, Raven, DR, Shaw, RS (AMS, ANIC, QM); 17, Forty Mile Scrub, 23.x-22.xi.1985, 21.x.1985-10.i.1986, RS & Heiner (DPIM); 3, Gordon's Mine area, 12-18.ii.1976, GM (QM); 1, Hidden Valley, 15mi W Paluma, 30.v.1969, DIC & RH (ANIC); 1, Iron Ra, 15-21.iv.1977, RS (DPIM); 3, Iron Ra, 28.iv-4.v.1968, 26.v-2.vi.1971, GM (UQ); 3, nr Iron Ra Airport, 20.xii.1971, DM & GH (AMS); 2, 1km E Iron Ra, 100', 13.v.1971, J. A. Brooks & JGB (ANIC); 2, Isabella Ck, 32km WNW Cooktown, 230m, 22.v.1977, IC & EE (ANIC); 11, Lockerbie, 6-10.vi.1969, GM (UQ); 1, 3km E Lockerbie, 30.i-4.ii.1975, GM (QM); 5, 24km NW Mareeba, 24-25.xi.1981, J. Balderson (ANIC); 1, Millstream Falls, 5.i.1967, DM & GH (AMS); 2, 19km N Moreton, 15-16.vii.1975, GM (QM); 7, Mount Garnet, i.1990, J. Hasenpusch (AMS); 6, 65km SW Mt Garnet, 11.ii.1975, A. H. W. (ANIC); 1, 4mi NE Mt Lomond, Iron Ra, 8.i.1972, DM & GH (AMS); 1, 7km N Ooline Scrub, 12.xi.1996-i.1997, P. Lawless (QM); 1, 5km W Port Stewart, 25-27.vi.1976, GSM (QM); 14, 2km SW Ravenshoe, 880m, 8-9.ii.1999, GM (QM); 1, Rockhampton, 1911, [Froggatt coll.] (ANIC); 1, Rocky R, Silver Plains, 6.i.1960, JW (ANIC); 2, Rocky R, McIlwraith Ra, 16.vi.1958, 14-16.xii.1964, GM (UQ); 1, Station Ck, 370m, 3-11.ii.1999, GM & DC (QM); 21, Tolga, 22.x.1985, 23-30.x.1985, 31.x-6.xi.1985, 10.xii.1986, JDB (DPIM); 1, 7km NE Tolga, 19.xii.1986-3.i.1987, RS & De Faveri (DPIM); 1, Windsor Tbld, 900m, 23-25.xi.1997, GM (QM); 1, Windsor Tbld, 30km from main rd, 28.xi-20.xii.1985, RS & JDB (DPIM); PAPUA NEW GUINEA: 2, 18mi N Port Moresby, Brown R, 10', 14-15.vii.1974, SJP (CMN); 4, ditto, except 16-18.vii.1974 (DPIM).

DESCRIPTION (male). *Colour*. Black, tarsi and head appendages reddish-brown

Length. 9-12mm.

Head (Fig. 2H). Eyes large, interocular ratio 5-6; first segment of labial palpi 1.5-2 × length second segment; anterior margin of frontoclypeus with a small angular tooth at junction of frons and clypeus, and convexly produced (or concavely excised) lateral to median teeth; frontoclypeus dull, strongly microreticulate and punctured, becoming rugose towards anterior.

Thorax (Figs 7E-F, 11C, 11J, 12B, 14F-G). Major male with anterior of pronotum strongly depressed medially, with two lateral 'tubercles', minor male may have evenly curved pronotum, as female; pronotum dull as elytra, or more shining than elytra, disc finely punctured, strongly microreticulate; lateral margin of pronotum entire; hypomeral ratio 0.4-0.7; elytra dull, intervals finely or obscurely punctured, strongly microreticulate; elytral striae 1-7 impunctate or almost so, without foveolate punctures, not apically deepened; stria 8 present, abbreviated by 0.5-1.5 × length mesepimeron; stria 9 similar; base of epipleuron not constricted; macropterous; meso-metasternal suture without median tubercle; anterior lobe of metasternum with narrow margins; anterior margin fore tibia with acute major teeth, separated by 2-4 convex minor teeth; posterior margin fore tibia abruptly emarginate 0.3-0.5 from base; mid femur elongate-ovate; hind femur broadest at middle, evenly tapered to apex, without subapical lobe; hind tibia not abruptly narrowed at base, ridges convergent; hind tibia slightly curved basally, very strongly curved in apical third; apical spine of hind tibia massive, almost as thick as wide and equal to first two to three tarsal segments, apex blunt, without articulated spur, tibial spine ratio 1.5; hind tarsus short, 0.25 × length hind tibia, segments 1-2 lobed ventrally, segments 1-4 almost equal in length, segment 5 = 3+4.

Abdomen (Figs 17G-H, 20B). Without deep punctate groove between last two ventrites; basal margin of pygidium evenly curved; parameres without apical setal fringe, asymmetric, left strongly curved, with convex apex; right paramere dorsally excavate, with large flat apical lobe; endophallus: ridges of flagellum strongly lobed; basal sclerite solid, roughly quadrate, with trilobed apex; ring sclerite with thick ring and two curved appendages; median sclerite irregular, strongly folded, adjacent to poorly defined flat plate; apex of endophallus with patch of small spinules.

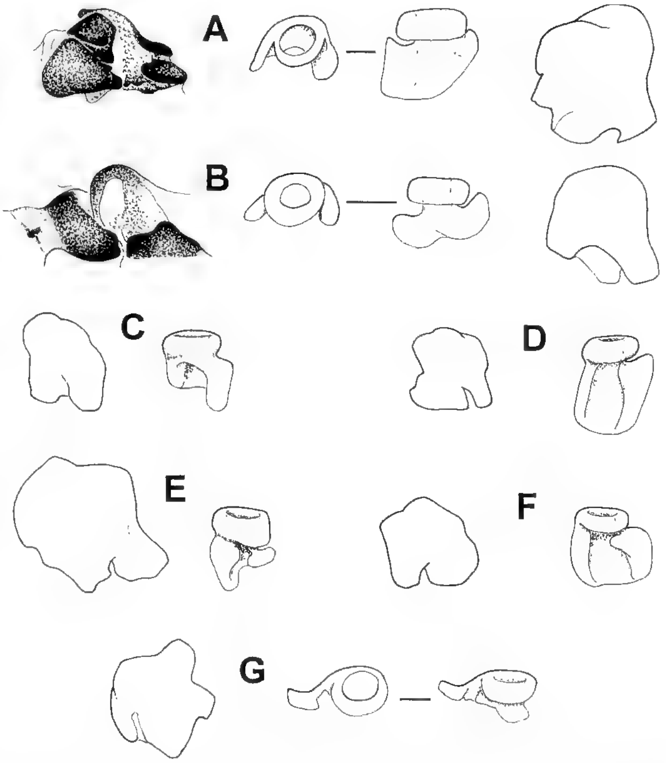

FIG. 20. *Temnoplectron* species, endophallic sclerites; A, *atropolitum* Gillet; B, *major* Paulian; C, *boucomonti* Paulian (Darwin); D, *boucomonti* (Cairns); E, *laeve* (Laporte); F, *rotundum* Westwood; G, *bornemisszai* Matthews. Not to scale.

Female (Fig. 11C). As above except: ventral edge of mid femur almost straight; spermathecal sclerite absent, without any dark areas around base of duct; spermatheca falcate, with globular base, slightly thickened median bend and gradually contracted apical lobe.

REMARKS. Matthews (1974) considered this to be a male morphological variety of *T. rotundum*, noting that the two 'forms' generally occurred together. They occur sympatrically between Forty Mile Scrub and Bamaga, Queensland, but have rarely been collected together at any site and probably occupy different habitats. Only *T. rotundum* is known from Groote Eylandt west to the Kimberleys, Western Australia, and only *T. major* is known south of Forty Mile Scrub.

DISTRIBUTION AND BIOLOGY (Fig. 28). Widespread in eastern Queensland, from Bamaga south to Taroom, westwards to Forty Mile Scrub, and is known from one locality in New Guinea, 20mi[les] N Port Morseby [Paulian (1985) erroneously gives the type locality as 200km N of Port Morseby]. It is a common open forest species, taken at human dung.

Temnoplectron monteithi sp. nov.
(Figs 3N, 10B-E, 13O, 18C-D, 22G, 30)

ETYMOLOGY. Named for Geoff Monteith, Queensland Museum, initiator and principle collector for the Wet Tropics dung beetle project.

MATERIAL. Holotype, ♂,QMT40074: 'NE Qld, 3.5km W Cape Tribulation (site 7), 5-9 Jan 1983, 680m, GM, RF, baited pitfall traps' (QM). PARATYPES. (323) QUEENSLAND: 10, same data as holotype (QM); 60, 4km W C Tribulation, rainforest, flight trap, baited pitfall traps, 720m, 23.ix-7.x.1982, GM, DY & GT (QM); 19, 4.5-5km W C Tribulation, 760-780m, 27.ix-7.x.1982, GM, DY & GT (QM); 12, ditto, except: 4km W, 720m, 23.ix-7.x.1982 (QM); 1, ditto, except: 4.5km W, pyrethrum knockdown, 760m, 29.ix.1982 (QM); 9, ditto, except: baited pitfall traps, 5-9.i.1983, GM (QM); 4, ditto, except: 3km W, 500m (QM); 63, ditto, except: 4km W, 760m (QM); 20, ditto, except: 5km W, 780m (QM); 8, ditto, except: 20-23.iv.1983, GM & DY (QM); 10, ditto, except: 23.ix-7.x.1983, GM, DY & GT (QM); 26, C Tribulation transect, 16°05S 145°26E, site 8, dung trap, night, 18-19.xi.1998, GM (QM); 2 ditto, except 750m, GM, Bouchard, O'Toole (QM); 13, Mt Halcyon, 16°03S 145°25E, pitfalls, 870m, 22-24.xi.1993, DC, GM, HJ & LR (QM); 1 ditto, except pyrethrum fogging trees & logs, 23.xi.1993 (QM); 1, ditto, except: berlesate, 24.xi.1993 (QM); 13, Mt Hemmant, 16°07S 145°25E, pitfall traps, 1050m, 25-27.xi.1993, GM, DC, HJ & LR (QM); 5, Mt Pieter Botte, 16°04S 145°24E, pitfalls & intercept, 950m. 21.xi-8.xii.1993, GM, HJ, LR & DC (QM); 2, ditto, except: 900m, GM & HJ (QM); 3, Roaring Meg Valley, 16°04S 145°25E, pitfall trap, 680m, 20-22.xi.1993, GM, DC, HJ & LR (QM); 1, ditto, except: 600m, 7-9.xii.1993, GM (QM); 2, Thornton Peak via Daintree, 1000-1300m, 20-22.ix.1981, GM & DC (QM); 4, ditto, except: 24-27.ix.1984, GSM (QM); 31, Thornton Peak, 11km NE Daintree, dung trap in rainforest, 1100m, 30.x-1.xi.1983, GM, DY & GT (QM); 1, ditto, except: 1100-1200m (QM); 1, ditto, except: 900m (QM).

DESCRIPTION (male). *Colour.* Black with brassy-green elytra, reddish-brown appendages and often reddish pygidium and elytral apex (generally darker on Thornton Peak).

Length. 3.5-5mm.

Head (Fig. 3N). Frontoclypeus strongly and closely punctured (rarely finely and sparsely), apical third dull, strongly microreticulate, and basal third shining, not or feebly microsculptured; lemon-shaped, genal angles rounded, anterior margin evenly curved or almost straight to prominent median tubercles; dorsal portion of eyes moderately small, broadest near base, interocular ratio 8-10; length first segment labial palpi 1-1.3 × second segment.

Thorax (Figs 10B, 13O). Disc of pronotum evenly convex, shining, not or feebly microreticulate, sides shining not or feebly microreticulate; pronotal disc strongly punctured throughout, or median area finely punctured; basal 2/3 of pronotal sides almost straight, basal margin evenly curved; circular depression at about 1/2 length sides of pronotum; lateral margins of pronotum usually with middle 0.15-0.2 effaced (typical of Mount Pieter Botte area), or complete (typical of Thornton Peak and Mount Hemnant), rarely with 0.3-0.5 of middle effaced; hypomeral ratio 0.15-0.35, stria not convergent with sides of pronotum; elytra strongly microreticulate, intervals finely or obscurely punctured; sides of elytra evenly convex; striae 1-7 evenly shallowly impressed and impunctate; stria 8 absent; stria 9 abbreviated, separated from elytral base by 2.5-3.5 × length mesepimeron, shallow, not delineated by fine ridge, with foveolate punctures throughout; stria 10 shallow, separated from base by about mesepimeron length; base of epipleural upper margin depressed, elytra constricted at this point; wing minute, 0.7mm long, unveined and strap-like; metasternal median lobe moderately strongly to finely and sparsely punctured; anterior of lobe separated from mid coxae by expanded triangular margins; middle of meso-metasternal border with small transverse tubercle; outer margin fore tibia with acute major teeth separated by 2-3 truncate minor teeth, inner margin shallowly concave; mid femur elongate-ovate; hind femur almost parallel-sided for most of length, without ventral lobe; hind tibia feebly curved, with short blunt apical lobe, tibial spine ratio 0.3-0.4, and prominent articulated spur about as long as first tarsal segment; hind tarsi long, combined length almost 1/2 length tibia; hind tarsal segment 1 ventrally lobed, 2 and 3 elongate rectangular, 4 quadrate and small (2/3 length 3), 5 almost as long as segments 3+4.

Abdomen (Figs 18C-D, 22G). Without deep punctate groove between last two ventrites; basal margin of pygidium evenly curved, without median tubercle; parameres asymmetric, apex of left paramere bluntly rounded, apex of right paramere triangularly produced; a short row of small setae on lower surface of each; endophallus: ridges of flagellum lobed and splayed at base; basal sclerite solid, roughly trapezoid; ring sclerite distorted, ring obscure with appendage drawn out laterally and twisted; median sclerite, two smooth lobes with median split containing small angular lobe.

Female (Fig. 10C-E). As above except: apical spur of female fore tibia angulate on inner margin; genitalia: spermathecal sclerite distinct, a transverse and narrow ridge; spermatheca C-shaped, gradually attenuated from base to apex.

REMARKS. This small globular species may be confused with *T. lewisense*, but the structure of stria 9, the depressed base of the epipleuron, the fore-tibial teeth and the female fore-tibial spurs separates them fairly easily.

DISTRIBUTION AND BIOLOGY (Fig. 30). *Temnoplectron monteithi* is confined to upland rainforest, at 600-1300m, on mountain massifs between the Daintree and Bloomfield Rivers, where it is abundant and the only small flightless *Temnoplectron* species. This species was listed as *Temnoplectron* sp. nov. in an altitudinal transect study undertaken on the Cape Tribulation ridge (Monteith, 1985).

Temnoplectron politulum Macleay
(Figs 3J, 9G-H, 15A-C, 19G, 21B, 23H, 31)

Temnoplectron politulum Macleay, 1887: 221; Gillet, 1925: 4; Paulian, 1934: 285; Matthews, 1974: 155; Cassis & Weir, 1992: 171

TYPE. Lectotype, Cairns (*vide* Cassis & Weir, 1992) seen (in ANIC).

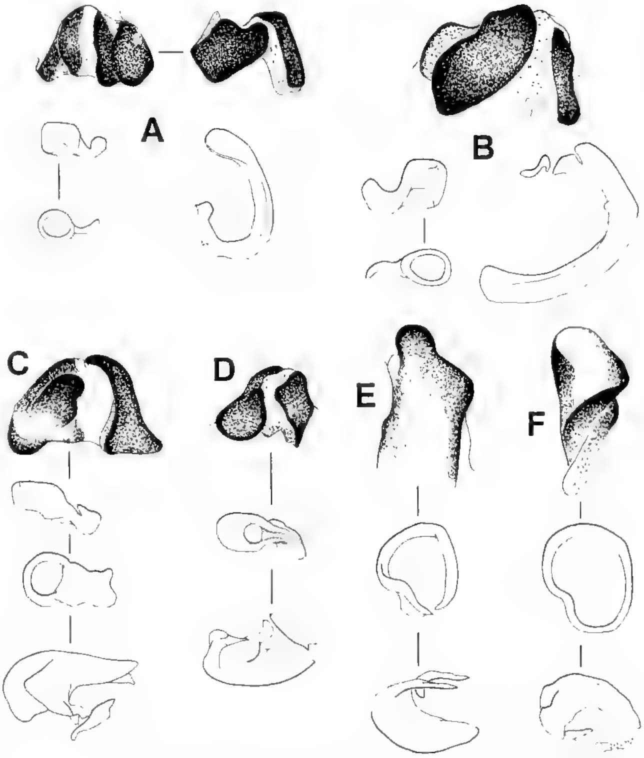

FIG. 21. *Temnoplectron* species, endophallic sclerites; A, *reyi* Paulian; B, *politulum* Macleay; C, *aeneopiceum* Matthews; D, *subvolitans* Matthews; E, *aeneolum* Lansberge; F, *wareo* sp. nov. Not to scale.

MATERIAL. (2016, including lectotype: abbreviated localities only) Lectotype, 3 paralectotypes (Matthews, 1974): Cairns, N Qld; QUEENSLAND: Atherton (AMS); 6km S Atherton (DPIM); 21km S Atherton (DPIM); 21km NE Atherton (ANIC); Baldy Mt (DPIM, QM); Bartle Frere, west base (QM); 2km S Beatrice R (QM); Bellenden Ker (QM); Boar Pocket Rd (DPIM); 3km W Bones Knob (QM); Boulder Ck (QM); Cardwell Ra, Kirrama and Windy Gap (ANIC, DPIM); Charmillin Ck (QM); Crater NP (QM); 18km up Davies Ck Rd (ANIC, DPIM, QM); Dianes Hill (ANIC); Douglas Ck (QM); 10km SE El Arish (ANIC); Figtree Ck (JCU); Forty Mile Scrub NP (DPIM); Gadgarra SF (QM); Graham Ra (QM); Heales Lookout (ANIC); Herberton Ra (ANIC); Hinchinbrook I. (QM); Hugh Nelson Ra (ANIC); Josephine Falls (ANIC); Kenny Rd (QM); Kirrama Ra (JCU, QM); Kjellberg Rd (QM); 10km S Koombooloomba (QM); 6km SW Kuranda (DPIM); Lake Barrine (ANIC); Lake Eacham (ANIC, QM); Lamins Hill (ANIC); Longlands Gap (ANIC); Maalan SF (QM); Malanda (ANIC); Malanda Falls (DPIM, QM); 3km S Malanda (ANIC); Massey Ck (ANIC, JCU, QM); Massey Ra (QM); McNamee NP (ANIC); Millaa Millaa Falls (ANIC, DPIM, QM); Millaa Millaa Lookout (QM); 9km W Millaa Millaa (ANIC); 14km SE Millaa Millaa (ANIC); Mission Bch (DPIM, QM); Mt Father Clancy (QM); Mt Fisher (QM); Mt Haig (ANIC); Mt Macalister (QM); Mt Nomico (AMS); Mt Smoko (QM); Mt Tyson (QM); Mt Williams (QM); Palmerston NP (ANIC, QM); Peeramon Quarry (JCU); Peeramon Scrub (QM); Pine Ck Tower (QM); Plath Rd (QM); Ravenshoe SF (ANIC); 9mi NE Ravenshoe (DPIM); 9.5, 11 & 18km SSW Ravenshoe (DPIM); Robson Ck (AMS, ANIC); Seaview Ra (QM); Sluice Ck (QM); South Johnston Forestry Camp & Research Station (DPIM, QM); Stone Ck (QM); 2km NNE Tarzali (ANIC); The Boulders (ANIC); The Crater (ANIC, DPIM, QM); 3km SE The Crater NP (ANIC); Tolga Scrub (ANIC); Topaz (QM); Tully (ANIC); Tully Falls (QM); Tully Falls Rd (QM); Upper Boulder Ck (QM); Upper Broadwater camp (QM); Upper Isley Ck (QM); Upper Plath Rd (QM); Wallaman Falls (DPIM, QM); Whitfield Ra (QM); Wongabel SF (ANIC); Yuccabine Ck (QM); 16km NE Yungaburra (ANIC).

DESCRIPTION (male). *Colour.* Black, tarsi and head appendages reddish-brown.

Length. 5.5-7.5mm.

Head (Fig. 3J). Lemon-shaped, genal angles evenly curved, anterior margin slightly angulate at frontoclypeal junction then evenly curved to prominent median tubercles; finely and moderately closely punctured (punctures separated by 3 diameters) near eyes, or entirely obscurely punctate, dull and densely microreticulate; eyes large, interocular ratio 3.8-4.3; length first segment of labial palpi 1-1.2 × second segment.

Thorax (Figs 9H, 15A-B). Surface of pronotum as closely but often more strongly punctured than head, microreticulate throughout but usually shining on disc where microreticulation shallow and sparse; basal 2/3 pronotal sides almost parallel-sided, abruptly contracted apically; base evenly curved; lateral border of pronotum entire; middle of pronotal sides with shallow oblique depression; hypomeral ratio 0.25-0.35, stria curved parallel to side of pronotum; elytra entirely microreticulate, intervals moderately strongly (as pronotum) to obscurely punctured; elytra with prominent humeri, almost straight behind these; discal striae, including stria 7, distinctly impressed, but 7 shallower than 1-6, at least in basal third and absent on apical half of elytron; apical half of striae 1-6 with scattered punctures, but not deepened; stria 8 reduced to short row of punctures, or short grooves, about 1/3 from base of elytra; stria 9 abbreviated from base by 2-2.5 × length mesepimeron; stria 10 abbreviated by length of mesepimeron; base of upper margin of epipleuron not depressed; macropterous; meso-metasternal border with flat triangular tubercle; metasternal anterior lobe finely and sparsely punctured, with margins triangularly expanded in corners; outer margin of fore tibia with acute major teeth separated by 3-5 slightly convex minor teeth, leading edge of tibia without recurved ridge and inner margin almost straight; mid femur elongate-ovate; hind femur elongate-oblong, dorsal and ventral edges broadly margined (keeled); hind tibia evenly curved, with long apical spine, 1.5 × length first tarsal segment, tibial spine ratio 1, and long articulated spur; hind tarsi c.1/3 × length of hind tibia; hind tarsal segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19G, 21B). Last two ventrites without deep punctate groove between; basal margin of pygidium evenly curved; parameres without apical fringe of setae, asymmetric, not excavated ventrally; left paramere acutely pointed in profile, not flattened laterally; right paramere broad and bluntly truncate; endophallus: basal sclerite C-shaped, with an appendage; flagellum with three equidistant lobes; ring sclerite with thick narrow-diameter ring and large curved appendage; median sclerite, two strongly folded and irregular plates around a median cleft.

Female (Figs 9G, 15C, 23H). Middle of outer intervals of elytra (6-8) shining and without microreticulation; apex of hind tibia simple; vaginal plate with broadly sclerotised well defined trapezoidal or quadrangular sclerite around vagina; spermatheca C-shaped, gradually contracted to blunt apex.

REMARKS. *Temnoplectron politulum* and its sister-species *T. reyi* are only reliably separated by examination of the male genitalia.

DISTRIBUTION AND BIOLOGY (Fig. 31). Occurs only south of the Black Mountain Barrier, and is allopatric with respect to its sister-species, *T. reyi*. The published record from Malanda (Gillet, 1925) is therefore probably correct. It is the only small *Temnoplectron* species to occur in the drier rainforest of Forty Mile Scrub.

Temnoplectron politulum is confined to rainforest, avoids edges and does not penetrate narrow strips of riparian rainforest in agricultural areas (Hill, 1995); it is nocturnal, attracted to a variety of baits but primarily dung, active on the ground, and rarely taken in flight intercept traps (Hill, 1996). This species commonly perches on low vegetation at night (Howden et al., 1991).

Temnoplectron reyi Paulian, stat. rev.

(Figs 1F, 3K, 9E-F, 12E, 15D, 19H, 21A, 23I, 31)

Temnoplectron reyi Paulian, 1934: 285.
Temnoplectron politulum sensu Matthews, 1974: 155 partim, nec Macleay, 1887; Cassis & Weir, 1992: 171.

TYPE. Holotype not seen (in MNHN).

MATERIAL. (1399: data reduced to locality, altitude, date, collector).QUEENSLAND: 1, Bakers Blue Mt, 900m, 11.ix.1981, GM & DC (QM); 2, Big Tbld, 618-740m, 20.xii.1990-8.i.1991, ANZSES (QM); 4, Black Mt Rd, Julatten, 21.xi-13.xii.1987, AWH (ANIC); 11, Bloomfield Ra, 24.xii.1979, RS (DPIM); 361, Bloomfield Rd, 20-27.vii.1974, 2.x.1974, 21-22.v.1975, GM, DC & Hancock (QM); 2, Cairns, E.W. Ferguson (ANIC); 332, 1.5-5km W-WNW C Tribulation, 50-780m, 23.ix-7.x.1982, 5-9.i.1983, 20-23.iv.1983, GM, DY, GT (QM); 1, 2km SSW C Tribulation, xi.1996, JS (ANIC); 1, Cedar Bay NP, 6.viii.1984, G. Morse (ANIC); 19, Cedar Pocket, 440m, 17-19.iv.1999, CR & IR (ANIC); 3, Cow Bay, 14-30.x.1987, AWH (ANIC); 1, Gold Hill, 550m, 1.xi.1976, RT & TW (ANIC); 2, Julatten, 29.x-30.xi.1987, AWH (ANIC); 16, 17-18km ESE Julatten, 400-1000m, 13-30.iv.1982, GM, DY & DC (QM); 1, Kuranda, 11.xi.1978, 'B.B.' (AMS); 5, 3km N Kuranda, 360m, 25.vi-3.viii.82, 27-31.vii.1982, SJP (ANIC); 3, 2km ENE Kuranda, 360m, 19-21.iv.1999, CR & IR (ANIC); 5, 7.5-8km NNW Kuranda, 20.xii.1984, 20.ii.1985, 29.ii.1988, RS. Halfpapp, DR (ANIC); 3, 13km NW Kuranda, 6.xii.1982, JT (ANIC); 1, Lake Eacham NP, 3-7.xi.1976, RT & TW (ANIC); 107, 5-10km W Mossman, 250-760m, 16.xii.1988-16.i.1989, 20.xii.1989-15.i.1990, 21.iv.1997, GM, GT, CB & Pavey (QM); 1, 8-12km NW Mossman, 300m, 26.xii.1989-15.i.1990, ANZSES (QM); 5, Mossman Gorge, 27.x.1966, EB (ANIC); 68, Mt Boolbun South, 850-950m, 4.xi.1995-11.i.1996, GM (QM); 2, 1.5km SE Mt Emmett, 100m, 23-24.iv.1999, CR (ANIC); 26, Mt Finnigan, 400-1100m, 20-27.vii.1974, 19-22.iv.1982, 1-2.vii.1982, GM, DC, DY, SJP (ANIC, QM); 12, 4km NE Mt Finnigan, 14-16.x.1980, TW (ANIC); 8, 5km ESE Mt Finnigan, 13-16.v.1981, A. Calder, JF & I. Naumann (ANIC); 5, Mt Halcyon, 870m, 22-24.xi.1993, GM, DC, HJ & LR (QM); 1, Mt Hartley, 1500-2000', 10.vi.1968, F. Parker (ANIC); 4, 2.5km S-SW Mt Hartley, 23-24.iv.1982, 8.xii.1993-2.ii.1994, GM, DY, DC & LR (QM); 4, 2.5km SW Mt Hartley, 1.i-5.iii.1994, LR (QM); 2, Mt Lewis, 900m, 26.vi-1.viii.1982, SJP (ANIC); 7, Mt Misery Rd, 730m, 6.xii.1990-17.i.1991, ANZSES (QM); 1, Mt Perseverance, 500m, 4.iv.1997, K. Abbott (ANIC); 1, Mt Pieter Botte, 900m, 21.xi-8.xii.1993, GM & HJ (QM); 7, Mt Sampson, 600-790m, 26-28.xii.1990-19.i.1991, ANZSES (QM); 72, 2-3km S-SSE Mt Spurgeon, 1100-1150m, 13-21.x.1991, 19-22.xi.1997, GM, HJ, DC, CB & CR (QM); 36, Oliver Ck, 10m, 4-7.iv.1974, 5-9.i.1983, DC & GM (QM); 23, Quaid Rd, 11.4km E quarry, 5.xii.1997-9.ii.1998, 17.iii-14.iv.1998, DeFaveri & Halfpapp (DPIM); 8, Reids Pocket, 420m, 17-19.iv.1999, CR & IR (ANIC); 11, Roaring Meg Valley, 680m, 20-22.xi.1993, GM, DC, HJ & LR (QM); 68, Saddle Mt, 640m, 3.xii.1995-7.ii.1996, GM & DC (QM); 1, Thornton Ra, 200m, 12-18.vii.1982, SJP (ANIC); 3, Upper Stewart Ck, 9.x.1969, RH (ANIC); 138, Windsor Tbld, 38, 39 & 46km from main rd, 850-1060m, 9.ix-25.xi.1976, 27.i.1980, 16.x.1983, 10.xi-26.xii.1983, 15.xii.1984, 20.xii.1985, 15.i.1986, 23.i.1988, 27.xii.1988-10.i.1989, 23-25.xi.1997, RS, JDB, Gough, Titmarsh, AWH, DR, GM & Schmidt (ANIC, DPIM, QM); 8, 1km NNW Yalbogie Hill, 420m, 19-21.iv.1999, CR & IR (ANIC).

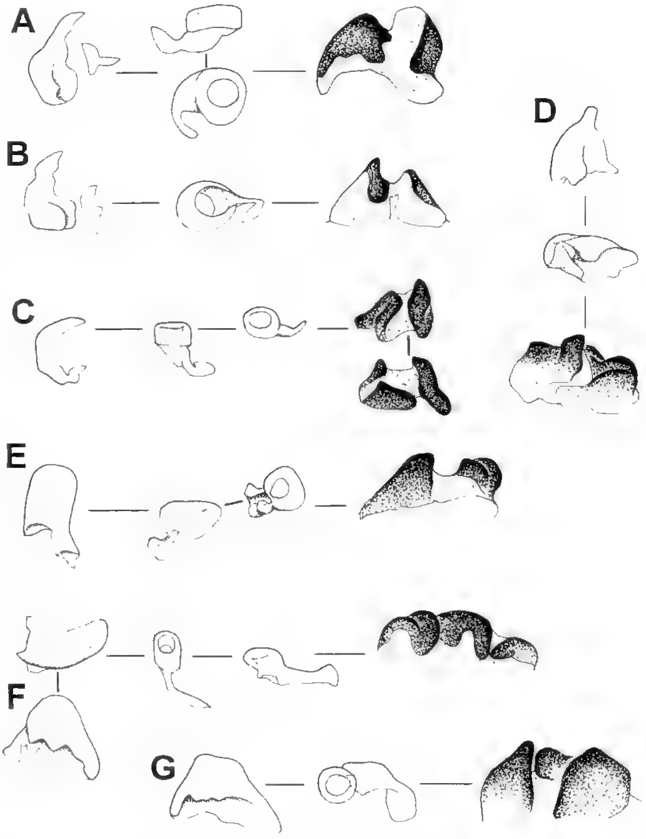

FIG. 22. *Temnoplectron* species, endophallic sclerites; A, *disruptum* Matthews; B, *diversicolle* Blackburn; C, *cooki* sp. nov.; D, *finnigani* sp. nov.; E, *involucre* Matthews; F, *lewisense* sp. nov.; G, *monteithi* sp. nov. Not to scale.

DESCRIPTION (male). *Colour.* Black, tarsi and head appendages reddish-brown.

Length. 5.5-7.5mm. Body shape relatively elongate (Fig. 1F).

Head (Fig. 3K). Lemon-shaped, genal angles evenly curved, anterior margin slightly angulate at frontoclypeal junction then evenly curved to prominent median tubercles; finely and sparsely or obscurely punctured, often more strongly near eyes, dull and densely microreticulate; eyes large, interocular ratio 3.8-4.3; length first segment of labial palpi 1-1.2 × second segment.

Thorax (Figs 9E, 12E, 15D). Surface of pronotum as closely but more strongly punctured than head, microreticulate throughout but more shining on disc where microreticulation shallow and sparse; basal 2/3 pronotal sides almost parallel-sided, abruptly contracted apically; base evenly curved; lateral border of pronotum complete; middle of pronotal sides with shallow oblique depression; hypomeral ratio 0.3-0.45, stria curved parallel to side of pronotum; elytra entirely microreticulate, intervals moderately strongly (as pronotum) to obscurely punctured; elytra with prominent humeri, almost straight behind these; discal striae, including stria 7, distinctly impressed, apical half of striae 1-6 with scattered punctures but not deepened; stria 7

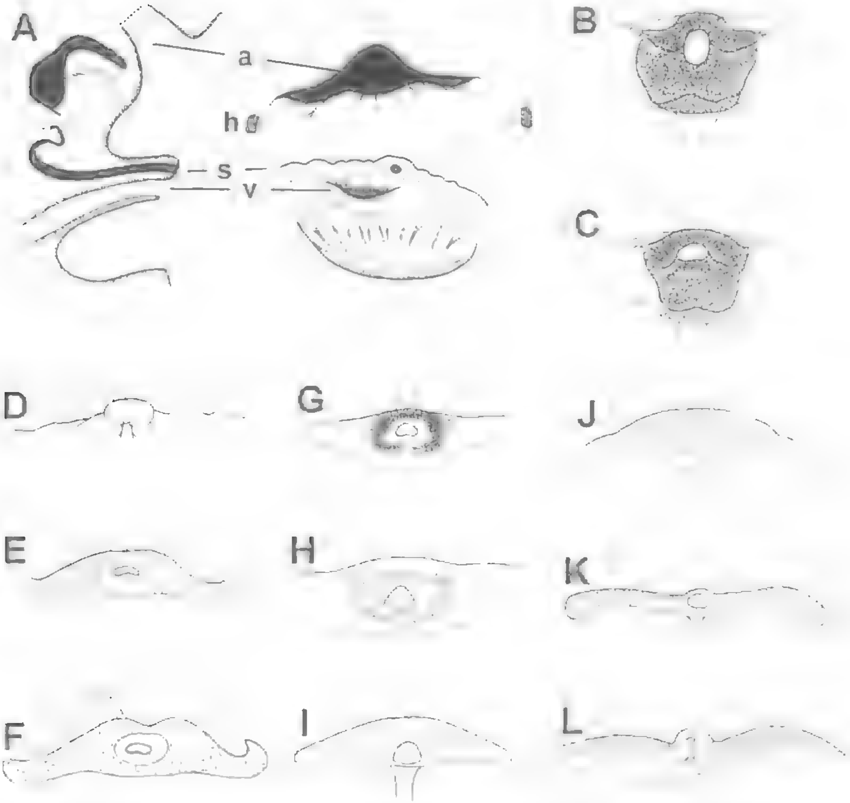

FIG. 23. *Temnoplectron* species; A, *rotundum* Westwood, apex of ♀ abdomen between tergite VIII and sternite VIII in section and apical view; spermathecal sclerite; B, *politulum* Macleay; C, *reyi* Paulian; D, *atropolitum* Gillet; E, *aeneopiceum* Matthews; F, *subvolitans* Matthews; G, *diversicolle* Blackburn; H, *cooki* sp. nov.; I, *disruptum* Matthews; J, *finnigani* sp. nov.; K, *lewisense* sp. nov.; L, *aeneolum* Lansberge. a = anus, h = hemisternite, s = spermathecal duct, v = vagina. Not to scale.

absent from apical half of elytron; stria 8 reduced to short row of punctures, or short grooves, about 1/3 from base of elytra; stria 9 abbreviated from base by 2-3 × length mesepimeron; stria 10 abbreviated by length of mesepimeron; base of upper margin of epipleuron not depressed; macropterous; meso-metasternal border with flat triangular tubercle; metasternal anterior lobe finely and sparsely punctured, with margins triangularly expanded in corners; outer margin of fore tibia with acute major teeth separated by 3-5 slightly convex minor teeth, leading edge of tibia without recurved ridge and inner margin almost straight; mid femur elongate-ovate; hind femur elongate-oblong, dorsal and ventral edges broadly margined (keeled); hind tibia evenly curved, with long apical spine, 1.5 × length first tarsal segment, tibial spine ratio 1-1.2, and long articulated spur; hind tarsi c.1/3 × length of hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19H, 21A). Last two ventrites without deep punctate groove between; basal margin of pygidium evenly curved; parameres without apical fringe of setae, asymmetric, not excavated ventrally; tip of left paramere incurved and flat in profile, tip of right incurved, narrow but truncate in profile; endophallus: basal sclerite C-shaped, without obvious appendage; flagellum with three equidistant lobes; ring sclerite with thick narrow-diameter ring and large curved appendage; median sclerite, two strongly folded and irregular plates around a median cleft.

Female (Figs 9F, 23I). Middle of outer intervals of elytra (6-8) shining and without micro-reticulation; apex of hind tibia simple; vaginal plate with broadly sclerotised well-defined trapezoidal sclerite around vagina; spermatheca C-shaped, gradually contracted to blunt apex.

REMARKS. *Temnoplectron reyi* was synonymised with *T. politulum* by Matthews (1974). The two species are almost identical but differ by: etching of striae 6 & 7; left paramere shape, right paramere shape. The male genitalia show the only reliable differences. The hind legs and female genitalia of these two species are similar and the surface sculpture of the head, pronotum and elytra shows the same range of variation.

The unique male type specimen of *T. reyi* was not made available. The name *reyi* is here applied to the species described above on geographic evidence, being described from Kuranda, which lies within the range of the above species and not *T. politulum*.

DISTRIBUTION AND BIOLOGY (Fig. 31). A common rainforest species from the Mount Finnigan area south to the northern slopes of the Lamb Range. It is allopatric with respect to its sister-species, *T. politulum*, the two species approach to within 10km of each other in the Lamb Range. There is a single specimen of *T. reyi* from Lake Eacham. All other material from this locality belongs to *T. politulum*, therefore it is likely that this specimen has been mislabelled.

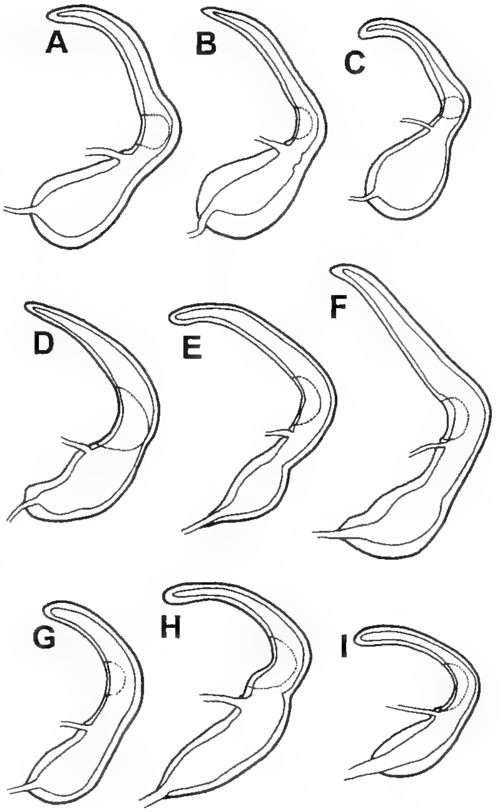

FIG. 24. *Temnoplectron* species, spermatheca; A, *major* Paulian; B, *bornemisszai* Matthews; C, *atropolitum* Gillet; D, *aeneolum* Lansberge; E, *subvolitans* Matthews; F, *aeneopiceum* Matthews; G, *involucre* Matthews; H, *diversicolle* Blackburn; I, *cooki* sp. nov. Not to scale.

Temnoplectron rotundum Westwood (Figs 2I, 7G-H, 11F, 12C, 14H-I, 17I-J, 20F, 23A, 32)

Temnoplectron rotundum Westwood, 1841: 51; Westwood, 1845: 118; Gillet, 1925: 3 [misdet.?]; Paulian, 1934: 285; Matthews, 1974: 152; Cassis & Weir, 1992: 171.

TYPE. Not seen (in HDO, examined by Matthews).

MATERIAL. (292: data reduced to locality, altitude, date, collector). NORTHERN TERRITORY: 1, Berry Springs, 9.i.1992, MBM (AMS); 4, Berry Springs Rd, 25-26.xi.1978, RS (DPIM); 6, Black Pt, Coburg Peninsula, 15-23.ii.1977, TW (ANIC); 1, ditto, except 29.i.1977, EE (ANIC); 1, Cahills Crossing, 29.v.1973, EM (ANIC); 2, Darwin, 2.iv.1916, G.F. Hill (ANIC); 1, 8km S Darwin, 30.xii.1977, M. Bainbridge (ANIC); 2, 15-27mi S Darwin, 29.i.1968, EM (ANIC); 1, 30mi E Darwin, G. F. Hill (ANIC); 8, Groote Eylandt, N.B. Tindale (AMS, ANIC, UQ); 1, Humpty Doo, 30.i.1959 (ANIC); 2, 6km E Humpty Doo, 9.ii-4.iii.1987, RS (DPIM); 1, Kakadu NP, 26.iii.1980, I. Naumann (ANIC); 25, Koongarra, 6-10.iii.1973, 27-28.xi.1974, RS, MU (ANIC, UQ); 2, Mudginberri, iii.1971, H.A. Standfast (ANIC); 2, Port Darwin, 1924 (AMS, WAM); 1, Smith Pt, Coburg Peninsula, 26.i.1977, EE (ANIC); 1, Snake Bay, Melville I., 4-6.ii.1968, EM (ANIC); 1, South Alligator R, 46mi WSW Mt Cahill, 20.v.1973, EM & MU (ANIC); 4, Wildman R, 30.xi.1978, RS (ANIC, DPIM); 19, Yirrkala, 1.ii.1968, EM (ANIC); QUEENSLAND: 70, Andoom, nr Weipa, 5-8.ii.1975, GM (QM); 1, Archer R Crossing, 17-18.vii.1975, GM (QM); 1, 7km S Batavia Downs, 4.iv-24.v.[no year], PZ & Roach (ANIC); 7, Cairns, 1918, Froggatt, Illingworth (AMS, ANIC, WAM); 7, Cairns (JCU); 4, Claudie R, nr Mt Lamond, 16.xii.1971, 7.i.1972, DM & GH (AMS); 2, 29km WNW Cooktown, 18.v.1977, IC & EE (ANIC); 3, ditto, except 31km NNW, 250m, 20.v.1977 (ANIC); 5, Davies Ck, 4-8.ii.1976, RS (DPIM); 6, Evans Landing, nr Weipa, 3-5.ii.1976, GM (QM); 1, 24km W Forsayth, 24.xii.1977, RS (DPIM); 10, Gordons Mine area, 12-18.ii.1976, GM (QM); 4, Hibberd Pt, 5-8.ii.1975, GM (QM); 23, Iron Ra., v.1961, 11.iv.1964, 28.iv-17.v.1968, 26.v-2.vi.1971, 12.vi.1971, JGB, Cantrell, IC, GM, MU, P. Ogilvie, JF (ANIC, QM, UQ); 4, nr Iron Ra Airport, 20.xi.1971, DM & GH (AMS); 4, 0.5mi S Iron Ra, 100', 14.v.1971, JGB (ANIC); 10, ditto, except 3mi[5km] S Iron Ra, 13-15.v.1971 (ANIC); 22, Lake

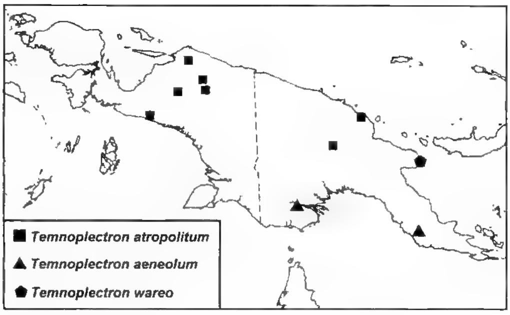

FIG. 25. Map of New Guinea showing distribution of *Temnoplectron* spp.

Boronto, 30.i-4.ii.1975, GM (QM); 12, Lockerbie, 31.iii-3.iv.1964, 13-27.iv.1973, IC, GM, MU (ANIC, UQ); 1, Lockerbie Scrub, 7-14.iv.1977, RS (DPIM); 3, Moreton Telegraph Station, 30.vi.1975, GM (QM); 2, 13km ENE Mt Tozer, 15.vii.1986, TW (ANIC); 5, ditto, except 14km ENE (ANIC); 1, ditto, except 9km NW, 2.vii.1986 (ANIC); 2, 1km N Rounded Hill, 5-6.x.1980, TW (ANIC); 1, Somerset, 16-17.iv.1973, GM (UQ); 1, Station Ck, Silver Plains, 26.ii.1959, JW (ANIC); 3, Watsonville, 18-25.v.1975, 22-27.iii.1980, RS (ANIC, DPIM, UQ); 1, Wenlock Crossing, 8.v.1986, F. Sattler (AMS).

DESCRIPTION (male). *Colour.* Black, tarsi and head appendages reddish-brown.

Length. 9-12mm.

Head (Fig. 2A). Eyes large, interocular ratio 4.5-5; length first segment of labial palpi 1.5-2 × length segment 2; anterior margin of frontoclypeus with a small angular tooth at junction of frons and clypeus, and convexly produced (or concavely excised) lateral to median teeth; frontoclypeus dull, strongly microreticulate and punctured, becoming rugose towards anterior.

Thorax (Figs 7G-H, 11F, 12C, 14H-I). Anterior of pronotum slightly depressed medially, but without lateral tubercles; disc of pronotum strongly punctured, shining, without obvious microreticulation or shallowly microreticulate, in contrast to dull elytra; sides of pronotum entirely margined; hypomeral ratio 0.6-0.9; elytral intervals finely punctured and strongly microreticulate; elytral striae 1-7 without foveolate punctures, shallowly impressed and almost impunctate throughout; stria 8 present, abbreviated at base by 1-3 × length mesepimeron, stria 9 similar; macropterous; meso-metasternal suture without median tubercle; metasternal anterior lobe with narrow margins; outer margin fore tibia with acute major teeth, separated by 2-4 convex minor teeth; inner margin fore tibia abruptly emarginate 0.25-0.3 from base; mid femur elongate-ovate but outer face medially swollen; base of elongate hind femur abruptly narrowed, weakly expanded near middle, apex of ventral surface expanded as a round lobe (overlapping excavate base of tibia); outer ridges of hind tibia divergent at base associated with abrupt constriction; hind tibia almost straight for basal 2/3, evenly curved in apical third; apical spine short and triangular, sharp and flat in profile, not obviously longer than apical tibial width, but as long as first two tarsal segments, without articulated spur; hind tarsus short, 0.25 × length hind femur, segments 1-3 lobed ventrally, segments 1-4 almost equal in length, segment 5 = 3+4.

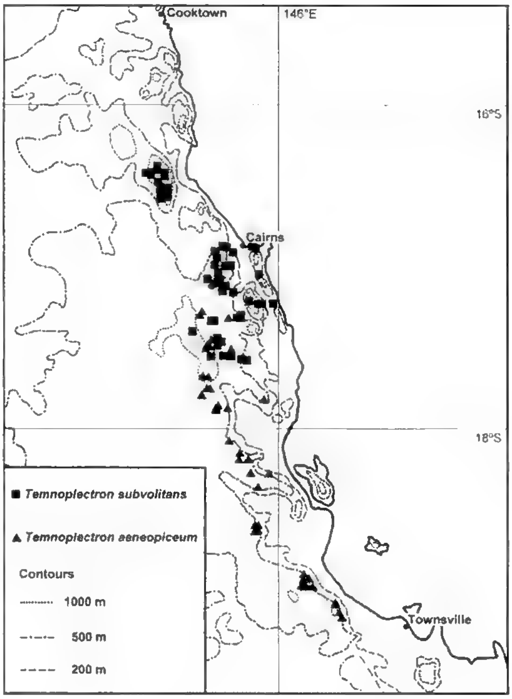

FIG. 26. Map of northeast Queensland, showing distribution of *Temnoplectron aeneopiceum* Matthews and *T. subvolitans* Matthews.

Abdomen (Figs 17I-J, 20F). Without deep punctate groove between last two ventrites; basal margin pygidium evenly curved; parameres without apical setal fringe, slightly asymmetric, left paramere thick, apex bluntly curved to feebly pointed; right paramere thick with short thick apical lobe; endophallus: ridges of flagellum strongly lobed; basal sclerite irregular, roughly quadrate, solid; ring sclerite with thick ring and curved appendage; median sclerite irregular,

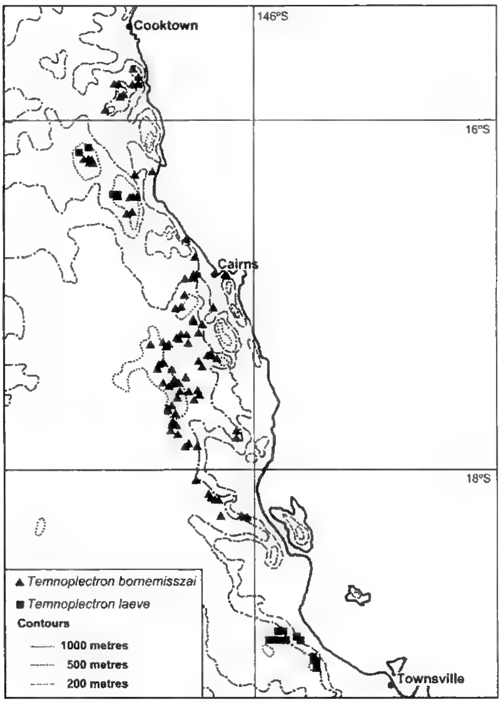

FIG. 27. Map of northeast Queensland, showing distribution of *Temnoplectron bornemisszai* Matthews and northern populations of *T. laeve* (Laporte).

strongly folded, adjacent to poorly defined flat plate; apex of endophallus with patch of large spinules.

Female (Figs 11D, 23A). As above, except: mid femur broadest near middle, lower edge shallowly curved; hind femur less elongate, base of hind tibia less strongly excavate; spermathecal sclerite feebly developed at base of spermathecal duct, but not darkened; spermatheca falcate, with bulbous base and apical lobe gradually contracted to apex.

DISTRIBUTION AND BIOLOGY (Fig. 32). Found from near Townsville, Queensland, north and west to Darwin, Northern Territory. The specimens from Cairns are old and may be from the northern Queensland region, rather than the city. The published record for Atherton (Gillet, 1925) may equally refer to *T. major* Paulian or *T. bornemisszai* Matthews. *Temnoplectron rotundum* and *T. major* are sympatric from Forty Mile Scrub to Bamaga, but rarely appear to be collected together (usually at light) and probably occur in different habitats or soils.

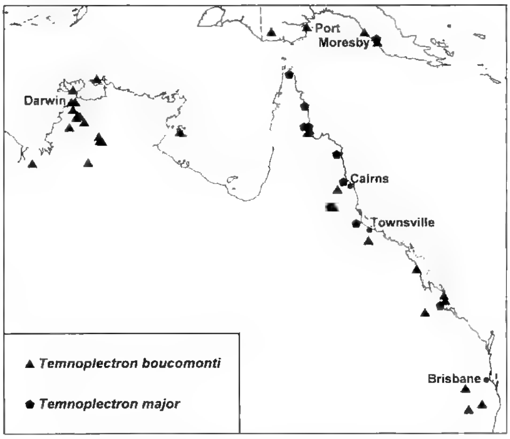

FIG. 28. Map of northern Australia and southern New Guinea, showing distribution of *Temnoplectron boucomonti* Paulian and *T. major* Paulian.

Temnoplectron subvolitans Matthews (Figs 3E, 5B-C, 8I-J, 13G-H, 19C, 21D, 23D, 24E, 26)

Temnoplectron subvolitans Matthews, 1974: 158; Cassis & Weir, 1992: 171.

TYPE. Holotype, Palmerston NP, 1.iv.1968, EM (ANIC); in ANIC seen.

MATERIAL. (722 abbreviated locality data given only). QUEENSLAND: Bartle Frere, west base (QM); Bellenden Ker, cableway (ANIC, QM); Boar Pocket Rd (ANIC, DPIM); Cedar Pocket (ANIC); Copperlode Falls (DPIM); Danbulla FR (ANIC, QM); Davies Ck (QM); Douglas Ck (QM); Graham Ra. (QM); Hugh Nelson Ra., 21km S Atherton (DPIM); Isley Hills (QM); Kauri Ck & 2km E (QM); Kjellberg Rd turnoff (QM); Lamins Hill (ANIC); Malaan Rd, 2km S highway (QM); Malaan SF (QM); 3-3.5km S Malanda (ANIC, QM); Massey Ck (JCU); Massey Ra (QM); Millaa Millaa Falls (ANIC, DPIM, QM); Mossman Bluff (QM); Mt Edith (JCU, QM); Mt Edith Rd, 2km from lake (ANIC); Mt Father Clancy (QM); Mt Haig (JCU); Mt Lewis (ANIC); 11, 13, 22, 23 & 29km up Mt Lewis Rd (ANIC, DPIM, QM); Mt Murray Prior (QM); Mt Spurgeon (ANIC, QM); Mt Williams (QM); North Bell Peak (QM); Palmerston NP (including 25 paratypes; ANIC); Pauls Luck (QM); Robson Ck (AMS, ANIC); Upper Isley Ck (QM); Upper Whitehall Gully (QM); Whitfield Ra (2 paratypes; ANIC); Windmill Ck (QM); Wongabel, 6km S Atherton (DPIM); 13km NNE Yungaburra (ANIC, DPIM).

DESCRIPTION (male). *Colour.* Black, elytra dark greenish, appendages and often apex of elytra, reddish-brown.

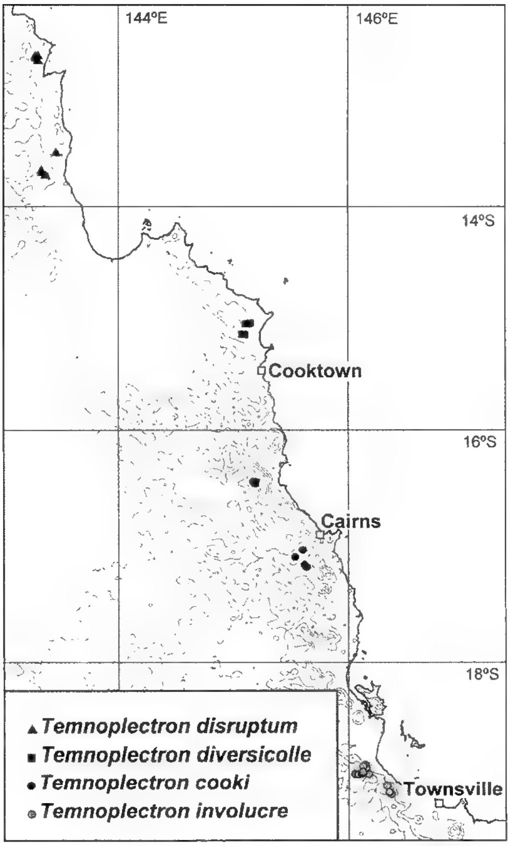

FIG. 29. Map of northeast Queensland, showing distribution of *Temnoplectron* species: *cooki* sp. nov., *disruptum* Matthews, *diversicolle* Matthews, *involucre* Matthews. Contours at 250m intervals.

FIG. 30. Map of northeast Queensland, showing distribution of *Temnoplectron* species: *finnigani* sp. nov., *lewisense* sp. nov., *monteithi* sp. nov. Contours at 100m intervals.

Length. 4.0-5.5mm (Carbine Tableland population on average larger than southern population).

Head (Fig. 3E). Frontoclypeus not evenly punctured, middle less strongly and more densely punctured; head unevenly microreticulate, with shining areas or entirely shining, not rugosely punctured anteriorly, rarely head more evenly punctured and microreticulate; anterior margin evenly shallowly curved between genal angles and median teeth; eyes large, interocular ratio 4-4.5; first segment of labial palpi 1.25 × length of second.

Thorax (Figs 5B-C, 8J, 13G-H). Pronotum evenly convex, moderately strongly and closely punctured (more strongly so on Carbine Tbld), disc shining, not microreticulate, extreme sides strongly microreticulate; lateral margins pronotum complete; hypomeral ratio 0.2-0.4; basal 0.3-0.5 elytra shining, without obvious microsculpture, in contrast with dull microreticulate apex; intervals moderately strongly punctured; striae 1-7 without sparse foveolate punctures on apical third, or punctures present but usually obscure on apical third of striae 1-6 at most; basal third of elytra with 10 striae; striae 7-9 bevelled on lower edge; stria 8 effaced in apical half and abbreviated at base by 0.5-1.5 × length mesepimeron; stria 9 abbreviated by 1-2 × length mesepimeron; base of epipleuron not constricted; wings either macropterous (all northern and some southern material) or reduced in size, with some

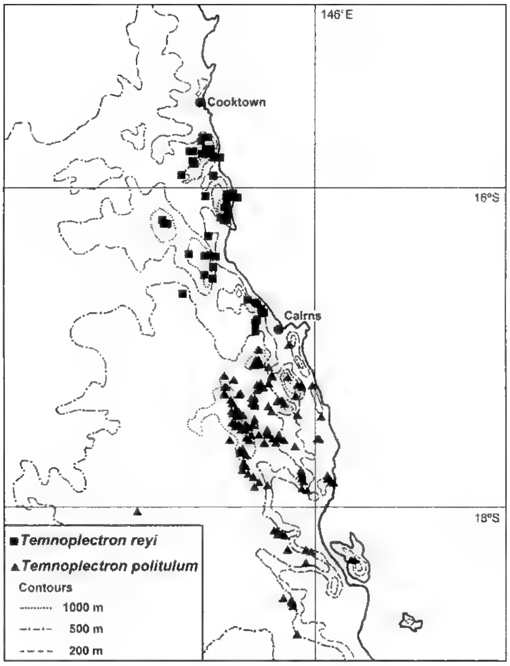

FIG. 31. Map of northeast Queensland, showing distribution of *Temnoplectron politulum* Macleay and *T. reyi* Paulian.

reduction of veins (some specimens at southern margin of range); meso-metasternal margin with almost flat triangular median tubercle; metasternum strongly punctured throughout, shining except anterior of median lobe microreticulate, anterior corners of lobe with narrowly triangular expanded margins; outer margin fore tibia with acute major teeth separated by 2-5 shallowly to sharply convex minor teeth (varies between tibiae), inner margin almost straight to shallowly sinuate; hind tibia evenly curved, almost parallel-sided for apical half; hind tibial spine sharply pointed, tibial spine ratio 0.75-1.25, with apical spur as long as first tarsal segment; hind tarsi long, c.0.35 × length hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19C, 21D). Ventrites 1-5 with basal row of small sensory pits; last two ventrites with shallowly impressed impunctate boundary; basal margin of pygidium evenly curved; parameres without apical setal fringe, roughly sinusoidal with deep ventral excavation towards base, but asymmetric, left with obliquely truncate apex, apex dorsally minutely toothed and ventrally produced, right paramere with preapical dorsal notch before rounded apex, which is flat and incurved; endophallus: basal sclerite pear-shaped with curved lateral lobe and small adjacent sclerite; flagellum long, lobes not equidistant; ring sclerite with thick-walled cylindrical ring and laterally flared lobe; median sclerite triangular but split by median cleft.

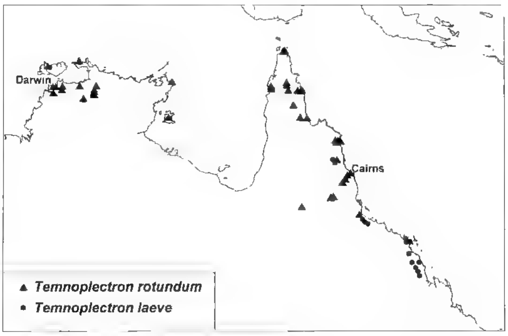

FIG. 32. Map of northern Australia, showing distribution of *Temnoplectron rotundum* and *T. laeve* Westwood.

Female (Figs 8I, 23D, 24E). As above, except: elytra shining, microsculpture confined to extreme base and apex, or apical half intervals 1-4 microreticulate; fore tibial spur slightly flattened, attenuated to curved apex; hind tibia with short apical lobe, less than half apical tibial width; genitalia: spermathecal plate generally sclerotised, relatively broad; spermatheca small and C-shaped, with doubly swollen base and thin apex.

REMARKS. This species was not clearly distinguished from *T. aeneopiceum* when originally described (Matthews, 1974), and the original description also included *T. finnigani*. Two paratypes of *T. aeneopiceum* from Mount Lewis belong to *T. subvolitans* and seven paratypes of *T. subvolitans* belong to *T. finnigani*.

Specimens from Carbine Tableland are isolated by almost 100km from the southern populations and are generally larger and more strongly punctured, but there are no genitalic differences. Brachyptery is only present amongst the southernmost populations.

DISTRIBUTION AND BIOLOGY (Fig. 26). Widespread between Millaa Millaa Falls and Cairns, from the western edge of Atherton Tableland to the coast, and also common on the Carbine Tbld. This is a rainforest species which occurs at a variety of baits.

Temnoplectron wareo sp. nov.
(Figs 3B, 4B, 8B-C, 13B, 19I, 21F, 25)

MATERIAL. Holotype, ♂, 'Wareo, Finsch Haven, L. Wagner' (SAM). Paratypes (3), Papua New Guinea: 3, Finsch Haven, L. Wagner (SAM).

DESCRIPTION (male). *Colour.* Body black, appendages reddish-brown.

Length. 5-6mm.

Head (Fig. 3B). Anterior margin of frontoclypeus strongly upraised, slightly concave before large sharp median teeth; head finely and sparsely punctured, impunctate or minutely punctured anterior to eyes; head shallowly microreticulate throughout; eyes large, almost touching base of clypeus, interocular ratio 3-3.5; lengths and widths of labial palp segments 1 & 2 equal or almost so.

Thorax (Figs 4B, 8B, 13B). Pronotum, shining, not microreticulate except extreme lateral margins; pronotal disc evenly convex, moderately finely and sparsely punctured; lateral margin of pronotum entirely effaced, or almost so; hypomeral stria absent or very short, hypomeral ratio <0.15; basal 0.5-0.75 elytra shining, not obviously microsculptured, contrasting with microreticulate apex and interval 8; elytra strongly convex in profile, but greatest height at or near base and apex almost truncate; apical half striae 1 and 2 deep, without punctures; intervals 1-3 depressed just before apex of elytra (or apices raised); stria 8 absent or reduced to 1-2 punctures, stria 9 abbreviated 2-2.5 × length mesepimeron; striae 9 and 10 with a few deep elongate punctures in basal third; base of epipleuron not constricted; macropterous; meso-metasternal suture with flat triangular median tubercle; anterior lobe of metasternum shining, sparsely punctured, with triangularly expanded corners; outer margin fore tibia with 2-4 convex minor teeth between acute major teeth, inner margin slightly concave; mid femur elongate-ovate; hind femur elongate-ovate, widest at middle; hind tibia evenly curved with short apical spine, tibial spine ratio 0.7; hind tarsi elongate, 0.4 × length of hind tibia, segment 1 ventrally lobed, 2, 3 and 4 elongate rectangular, decreasing in length, segment 5 almost equal length segments 3+4.

Abdomen (Figs 19I, 21F). Suture between last two ventrites not or weakly grooved, without row of punctures; basal margin of pygidium not medially swollen or produced; parameres without apical setal fringe, symmetrical or almost so, short and broad, with triangular tooth on venter of apices, which are reflexed and overlapping; endophallus: with roughly C-shaped basal sclerite and appendage, short and broad diameter ring sclerite without appendage, elongate and simply folded median sclerite.

Female(Fig. 8C). Spermathecal sclerite thin, poorly demarcated and split by duct; spermatheca C-shaped, evenly tapering to tip.

REMARKS. *Temnoplectron wareo* is similar to *T. aeneolum*, differing by larger eye size, more elongate elytra and the male genitalia.

DISTRIBUTION AND BIOLOGY (Fig. 25). Known only from old specimens collected on the Huon Peninsula, Papua New Guinea. The biology is unknown.

TABLE 1. Checklist of *Temnoplectron* Westwood species.

Temnoplectron Westwood 1841: 51
aeneolum Lansberge 1885: 375
aeneopiceum Matthews 1974: 157
atropolitum Gillet 1927: 252
– *heurni* Paulian 1985: 225; syn. nov.
– *howdeni* Paulian 1985: 227; syn. nov.
bornemisszai Matthews 1974: 149
boucomonti Paulian 1934: 285
– *yuleanum* Balthasar 1965: 15
= *laevigatum* Matthews 1974: 151; syn. nov.
cooki Reid & Storey, sp. nov
disruptum Matthews 1974: 154
diversicolle Blackburn 1894: 204
finnigani Reid & Storey, sp. nov
= *subvolitans* Matthews 1974: 158, partim
involucre Matthews 1974: 156
laeve (Laporte 1840: 72)
?– *laeve* Waterhouse 1874: 175
lewisense Reid & Storey, sp. nov.
major Paulian 1985: 226
– 'rotundum morph B', Matthews 1974: 153
monteithi Reid & Storey, sp. nov
politulum Macleay 1887: 221
reyi Paulian 1934: 285; stat. rev
rotundum Westwood 1841: 51
subvolitans Matthews 1974: 158
wareo Reid & Storey, sp. nov.

PHYLOGENETIC ANALYSIS

METHODS. Thirty informative characters (Table 2) were scored for each of the 19 *Temnoplectron* species plus two outgroup taxa (Table 3) and the data analysed using PAUP (Swofford, 1993), with character examination by MacClade (Maddison & Maddison, 1992). The outgroup taxa were *Monoplistes* and *Diorygopyx*, which in

TABLE 2. Character list for phylogenetic analysis of *Temnoplectron* species.

1. length. *0.* <8mm. *1.* 8+mm.

Head

2. eyes. *0* small, ID 7+. *1.* large, ID <7.

3. frontoclypeus. *0.* evenly punctured. *1.* rugose towards margins.

4. clypeal margin. *0.* evenly curved to median teeth *1.* expanded then concave beside teeth.

Thorax

5. lateral pronotal margin. *0.* complete. *1.* partially or entirely effaced.

6. elytra. *0.* black. *1.* greenish.

7. female elytra. *0.* microreticulate. *1.* without microsculpture in outer intervals at least.

8. stria 1. *0.* shallowly impressed at apex. *1.* strongly deepened at apex.

9. stria 8. *0.* present on most of basal half. *1.* reduced to short stria in second quarter. *2.* reduced to row of punctures or absent.

10. wing development. *0.* macropterous. *1.* wings partly reduced. *2.* reduced to single veined scale.

11. metasternum anterior lobe. *0.* with narrow margins.*1.* triangularly expanded margins.

12. major fore tibial teeth. *0.* acute. *1.* reduced (in fresh specimens) and obtuse.

13. minor teeth between major teeth of fore tibia. *0.* >1. *1.* 1-2 only.

14. fore tibia minor teeth. *0.* sharp or convex. *1.* truncate.

15. inner margin male fore tibia. *0.* straight or angulate. *1.* excavate in basal half.

16. male mid femur. *0.* evenly curved. *1.* with strong preapical lobe.

17. male posterior tibial spine. *0.* short and blunt, like female. *1.* elongate and thickened. *2.* flat and triangular.

18. male posterior tibial spine. *0.* with articulated spur. *1.* without spur.

19. lobed hind tarsal segments. *0.* absent (outgroup) or 1 only. *1.* 1-2. *2.* 1-3.

22. meso-metasternal suture. *0.* simple. *1.* with median triangular lobe.

30. major male pronotum. *0.* evenly convex. *1.* anteriorly depressed.

Abdomen

20. basal margin, male pygidium. *0.* simple. *1.* swollen medially. *2.* with deep transverse groove.

21. ventral margin of parameres. *0.* without row of fine hairs. *1.* with row of fine hairs.

23. spermathecal base. *0.* gradually attenuated. *1* abruptly swollen.

24. spermathecal plate. *0.* absent. *1.* semicircular. *2.* sclerotised ring. *3.* thick and quadrate. *4.* transverse strip. *5.* two transverse strips split by ostiole.

25. basal sclerite of endophallus. *0.* flat & C-shaped. *1.* solid, cuboidal or pyramidal. *2.* solid C-shaped, with concave face.

26. ring sclerite. *0.* thin & circular. *1.* thick, with thick-walled extension. *2.* ring extended as elongate twisted shute or almost right-angled lobe.

27. median sclerite. *0.* a simple folded plate. *1.* more complex.

28. tip of left paramere. *0.* evenly curved or with small basal lobe. *1.* truncate and incurved, with excavate upper surface. *2.* acute and straight.

29. tip of right paramere. *0.* evenly curved or with small basal lobe. *1.* truncate and incurved, with excavate upper surface.

combination are considered to be the sister-taxon to *Temnoplectron* (Matthews, 1974).

RESULTS. With all characters included, 16 minimum-length trees, 79 steps long, were found from 50 randomly seeded analyses. These trees belonged to two groups: (a) 12 trees showing (*atropolitum* + *rotundum*-group) sister to all other species, with the following structure: ((*aeneolum* + *wareo* + *disruptum* + (flighted species + flightless species))); (b) 4 trees showing non-monophyly of brachypterous species: ((*involucre* etc) + ((*atropolitum* + (*rotundum* species group) + (((*aeneopiceum* + *subvolitans*) + (*politulum* + *reyi*)) + ((*aeneolum* + *wareo*) + (*disruptum* + (*cooki* + *diversicolle*)))))). The formation of this last clade (*disruptum* + (*cooki* + *diversicolle*)) was perhaps the most important difference between the two resolutions. The strict consensus of these trees is shown (Fig. 33). The same result was obtained if the outgroup was *Diorygopyx* only (76 steps), but if the outgroup was *Monoplistes*, only 4 trees were obtained, identical to cluster (b).

If the character for wing-length (#10) was excluded, with OG = *Diorygopyx* + *Monoplistes*, or *Monoplistes* only, 4 minimum-length trees were obtained, as in cluster (b). With #10 excluded and OG = the flightless *Diorygopyx* only, 121 trees were obtained with little internal resolution. In the analyses using all characters, consistent resolved clades include: (*bornemisszai* + *laeve*), (*major* + *rotundum*), (*atropolitum* + the *rotundum* species-group), (*aeneolum* + *wareo*), (*aeneopiceum*, *subvolitans*, *politulum* and *reyi*) and (*involucre* + (*lewisense* + (*finnigani* + *monteithi*))).

DISCUSSION

Intense collecting of scarabs in the last 20 years means that we can be relatively certain of the accuracy of our knowledge of species' ranges in the Wet Tropics and therefore it is possible to

TABLE 3. Data matrix.

Taxa	Character Numbers																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
T. aeneolum	0	1	0	0	1	[illegible]	0	1	0	0	1	0	0	[illegible]	0	[illegible]	1	1	[illegible]	1	1	1	[illegible]	0	2	1	0	0	0	0
T. aeneopiceum	0	1	0	[illegible]	1	1	1	1	[illegible]	0	1	0	0	0	0	[illegible]	1	0	0	0&1	[illegible]	1	0	1	2	2	1	2	0	0
T. atropolitum	1	1	0	0	0&1	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	[illegible]	0	[illegible]	0	1	1	[illegible]	0	0	0
T. bornemisszai	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1	0	1	4	1	[illegible]	1	0	0	0
T. boucomonti	1	1	1	1	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0	0	1	[illegible]	0	1	1	1	2	[illegible]	[illegible]	0	1	4	1	[illegible]	1	0	0	[illegible]
T. cooki	0	0	0	0	0&1	0	0	0	1&2	[illegible]	1	0	0	[illegible]	0	0	1	[illegible]	0	0	0	1	0	2	0	2	1	1	1	[illegible]
T. disruptum	0	1	0	0	1	0	0	0	[illegible]	0	1	0	0	[illegible]	[illegible]	0	1	0	0	[illegible]	0	1	[illegible]	1	2	2	1	1	1	0
T. diversicolle	0	0	0	0	1	1	0	0	1&2	1	1	0	0	1	0	0	1	0	0	0	0	0&1	0	2	[illegible]	[illegible]	1	1	1	0
T. finnigani	[illegible]	[illegible]	0	0	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	1	1	1	[illegible]	1	[illegible]	2	1	0	[illegible]	[illegible]
T. involucre	0	[illegible]	0	[illegible]	[illegible]	1	0	[illegible]	2	[illegible]	1	1	0	0	0	0	0	0	[illegible]	[illegible]	0	1	[illegible]	4	[illegible]	2	1	0	[illegible]	0
T. laeve	1	1	1	0	0	0	0	0	[illegible]	[illegible]	0	1	1	1	1	1	1	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	4	1	1	1	0	1	0
T. lewisense	0	0	0	0	0&1	1	0	0	2	0	1	0	[illegible]	0	0	[illegible]	0	[illegible]	0	0	1	1	0	4	1	[illegible]	1	?	[illegible]	[illegible]
T. major	1	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	[illegible]	[illegible]	1	1	1	1	1	[illegible]	[illegible]	0	[illegible]	[illegible]	1	1	1	0	[illegible]	1
T. monteithi	0	0	0	0	0&1	1	[illegible]	0	2	2	1	0	0	1	0	0	0	[illegible]	0	2	1	1	[illegible]	4	1	2	1	1	1	0
T. politulum	0	1	0	0	0	0	1	[illegible]	[illegible]	[illegible]	1	0	0	0	0	0	1	[illegible]	0	[illegible]	[illegible]	1	[illegible]	4	0	[illegible]	1	2	1	[illegible]
T. reyi	0	1	0	0	0	0	1	0	2	0	1	0	0	0	0	0	1	0	0	0	0	1	0	2	0	2	1	?	1	0
T. rotundum	1	[illegible]	1	1	0	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0	1	0	2	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	1	1	1	0	[illegible]	1
T. subvolitans	0	[illegible]	0	0	0	1	1	[illegible]	0	0&1	1	0	[illegible]	0	0	0	1	0	0	0	[illegible]	1	[illegible]	1	2	2	1	?	1	[illegible]
T. wareo	0	1	0	0	[illegible]	0	0	1	2	0	1	0	0	0	0	1	1	1	0	0	1	1	[illegible]	[illegible]	[illegible]	0	1	0	0	0
Monoplistes	0	0&1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	[illegible]	0	2	0	0&1	0	0	?	?	1	?	[illegible]	[illegible]
Dioryctopyx	0	0	0	0	0	0	0	0	0	[illegible]	1	0	0	0	1	0	0	0	0	2	[illegible]	[illegible]	[illegible]	0	[illegible]	0	?	0	[illegible]	[illegible]

discuss allopatry and sympatry with some confidence.

The fully resolved parts of all the minimum-length trees are remarkable for the number of allopatric sister taxa, including some volant species: (i) (*monteithi* + *finnigani*); (ii) (*lewisense* + i); (iii) (*involucre* + ii); (iv) (*aeneolum* + *wareo*); (vi) (*politulum* + *reyi*). Even the species pairs (*aeneopiceum* + *subvolitans*) and (*bornemisszai* + *laeve*) are almost allopatric, each overlapping in small regions where they may be separated by altitude or habitat. Furthermore, there are additional allopatric sister-taxa, depending on which resolution provides a more accurate phylogenetic hypothesis: from clades (a) (*diversicolle* + (*involucre* etc)), or from clades (b) (*cooki* + *diversicolle*) and (*disruptum* + (*cooki* + *diversicolle*)). However, none of the dry forest or woodland species, *T. rotundum*, *T. major* and *T. boucomonti*, shows allopatric relationships, although they may be separated by differences in preferred microhabitat or soil type (which may explain the diversity in fore and hind tibial morphology shown by this group). For example, all three of these species occur in the vicinity of Forty Mile Scrub and are relatively widespread.

Flightlessness has at least two origins, in clade (*aeneopiceum* + *subvolitans*) and ancestral to (*involucre* + (*lewisense* + (*monteithi* + *finnigani*))). It may also have occurred independently in (*disruptum* + (*cooki* + *diversicolle*)), if this clade is considered in preference to (*cooki* + (*diversicolle* + (*involucre* etc))). In (*aeneopiceum* + *subvolitans*), flightlessness only occurs in a small part of the range of *T. subvolitans*, where this overlaps with its sister-species, *T. aeneopiceum*. This curious form of habitat partitioning may have resulted from hybridisation of the two species, but among 100s of specimens examined we have been unable to find any specimens with other traits that might be expected for hybrids, for example intermediate genital morphology. Aside from *T. subvolitans*, every flightless species occupies a separate block of forest except the Carbine Tableland (two, but they are easily separated by size and habitat preference) (Figs 29-30). It is likely that such a pattern is due to ancient aridity events causing the loss of forest corridors connecting each block (Nix et al., 1991; Moritz et al., 1995). Speciation is therefore by vicariance rather than dispersal. This explanation is supported by the variation of tibial morphology in the clade (*involucre* + (*lewisense* + (*monteithi* + *finnigani*))), in which the currently geographically and sexually isolated species appear to preserve the longitudinally clinal range of variation of a widespread ancestor. In this clade, flightlessness is a precursor to speciation.

If the allopatric sister-taxa listed above have formed due to vicariance events, precise geographic sites of such barriers include the following: Daintree River valley; Bloomfield River valley; Barron River Valley. If the ancestor to (*lewisense* + (*monteithi* + *finnigani*)) was evenly spread through the region now occupied by these species, the phylogeny indicates the northern break at the Bloomfield River was more recent than the southern at Daintree River. At times of greater aridity, such broad valleys were reduced to dry forest or woodland (Hopkins et al.,

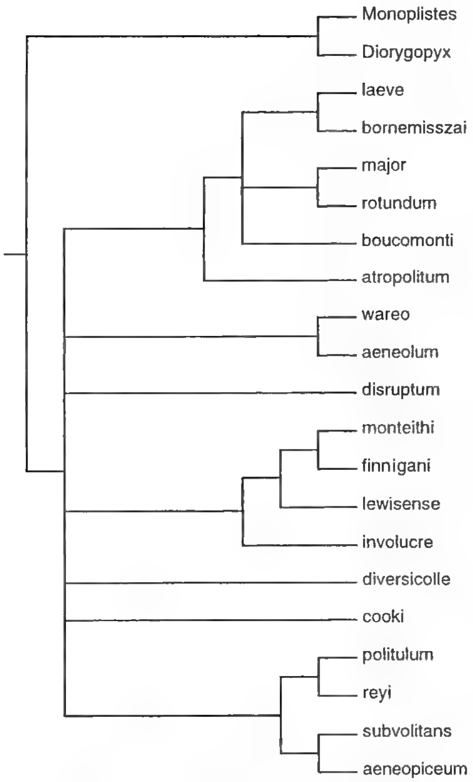

FIG. 33. Strict consensus tree of 16 minimum-length trees for *Temnoplectron* species from analysis of 30 characters.

1996). However, three species have isolated populations on either side of such barriers, *T. cooki*, *T. laeve* and *T. subvolitans*, which have failed to morphologically diverge as a whole, although showing differences in average sculpture and size. Failure to diverge may be due to relatively recent isolation of these populations, or the slowness of their particular 'morphological clocks' (although there may be considerable molecular divergence). Such populations are certainly incipient species, given the semi-permanent nature of the modern culturesteppe.

There are three species characteristic of drier habitat (vine thicket and woodland in the monsoon belt), which probably belong to a single clade (*boucomonti* + (*major* + *rotundum*)). It is therefore likely that the presence of *Temnoplectron* species in drier habitat than rainforest is due to a single event.

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TWO NEW GENERA OF TESSARATOMIDAE (HEMIPTERA: HETEROPTERA: PENTATOMOIDEA)

DAVID PATRICK SINCLAIR

Sinclair, D.P. 2000 12 31: Two new genera of Tessaratomidae (Hemiptera: Heteroptera: Pentatomoidea). *Memoirs of the Queensland Museum* **46**(1): 299-305. Brisbane. ISSN 0079-8835.

Two new genera of the shield bug family Tessaratomidae are described and illustrated. *Tibiospina* gen. nov., with the type species *T. darlingtoni* sp. nov., is from several higher altitude rainforest localities in the Wet Tropics region of north Queensland. *Pseudosepina* gen. nov., with the type species *T. longula* sp. nov., is based on a single female specimen from central Madagascar. ❒ *Heteroptera, Tessaratomidae, new genera, Tibiospina, Pseudosepina, Queensland, Madagascar.*

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The shieldbug family Tessaratomidae occurs mainly in tropical and subtropical regions of the Old World at altitudes up to 3,500m. It includes many large, spectacular and colourful shield bugs with body lengths ranging from 8-44mm. The family includes three subfamilies, viz. Tessaratominae, Oncomerinae and Natalicolinae (Kumar, 1969a,b; Kumar & Ghauri, 1970). A recent world checklist includes 49 genera and 'about 235 species' (Rolston et al, 1993).

While undertaking a cladistic, generic revision of the Tessaratomidae (Sinclair, 1989) specimens of two new genera were discovered, one from tropical north Queensland, belonging to the subfamily Oncomerinae, and the other from Madagascar, belonging to the Tessaratominae. These are described here.

MATERIALS AND METHODS

Description of Genitalia. Descriptions of the male aedeagal conjunctival processes were made with the aedeagus viewed in profile while lying on its side in the natural position. The terms 'distal' and 'proximal' conjunctival processes are applied in a relative sense following Kumar & Ghauri (1970). The description of the female spermatheca commences from the bulb-end of the duct.

Preparation of Genitalia. Genital segments were cleared by immersion in boiling 10-15% KOH for 5-30 minutes. After several washes in tap water the segments were dissected using fine jewellers forceps and micropins mounted on the apex of matchsticks. The aedeagus was teased into its fully everted state by using fine jewellers forceps to grasp the basal plates of the aedeagal phallosoma, and another pair to grasp the base of the vesica inside the phallotheca. After examination in tap water or 70% alcohol the genitalia were stored in glycerine-filled microvials beneath the specimen.

Line Drawings. Line drawings were made using a camera lucida attached to a Wild binocular microscope. Each scale bar applies to the line drawing closest to it.

Abbreviations. Female genitalia: igx1, incised posterior margin of gonocoxa 1. Male genitalia: pygophore: bp, base of paramere; dr, dorsal rim; drg, dorsal ridge; eo, external opening; p, paramere; lp, prominent ledge of pygophore; ps, pygophoral spine; svr, sharp medially directed ridge of ventral rim; sw, subvertical wall; tp, tongue-like process; vr, ventral rim; aedeagus: conjunctival processes: dld, dorsolateral distal; ld, laterodistal; vld, ventrolateral distal; vlp, ventrolateral proximal; v, vesica. Legs: ts, hind-leg tibial spine. Institutions: AMNH, American Museum of Natural History, New York; QM, Queensland Museum, Brisbane; SAM, South Australian Museum, Adelaide; ZIL, Zoological Institute, Leningrad.

Subfamily ONCOMERINAE Stål

Tibiospina gen. nov.

TYPE SPECIES. *Tibiospina darlingtoni* sp. nov.

ETYMOLOGY. Referring to the distinctive tibial spine of the male.

DIAGNOSIS. Head with lateral margins of jugae deeply incised medial to preocular tubercle (Fig. 2B). Male: abdominal tergum 7 with posterior

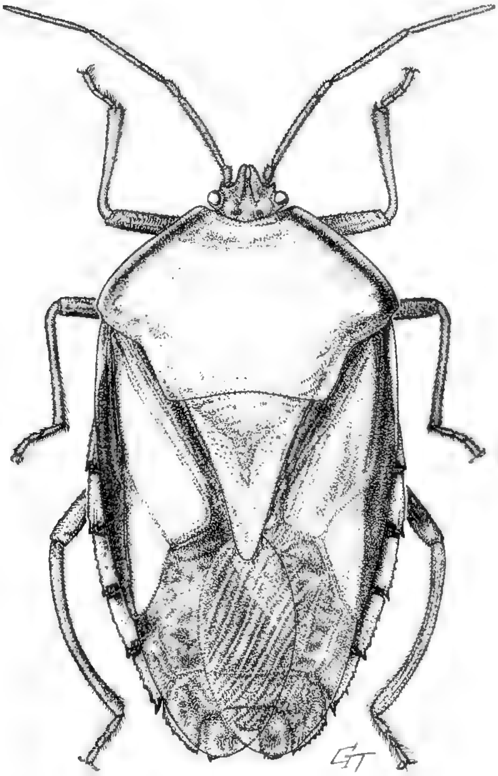

FIG. 1. *Tibiospina darlingtoni* gen. et sp. nov., ♀, dorsal view.

margin deeply incised to receive greatly enlarged pygophore (apex of incision reaching slightly posterior of an imaginary line drawn between the posterior angles of abdominal laterotergites 5) (Fig. 2C); abdominal sternum 7 medially longer than combined length of abdominal sterna 3-6 (Fig. 2D); posterior angles of abdominal segment 7 produced posteriorly, weakly dorsally and medially over lateral margins of pypophore (Fig. 2C); hind tibiae distinctly bowed, bearing a prominent preapical, anteromedially directed spine (Fig. 2A); pygophore with a distinctive pair of heavily sclerotised spines arising from the lateral margins of the exterior opening, spines curved posterodorsally then laterally and ventrally (Figs 2C, 3A, B). Female: hind tibiae bowed (Figs 1, 2F), lacking a medial, preapical spine.

DESCRIPTION. *Head* (Fig. 2B). Wider than long; antennae five-segmented, apex extending to scutellar apex, jugae narrowly separated to contiguous anterior to tylus; rostral segment 1 surpassing bucculae posteriorly; rostral apex reaching to mesosternum.

Thorax. Posterior pronotal margin produced over scutellar base (Figs 1, 2A); scutellum longer than wide, apex reaching abdominal tergum 6 (Fig. 2C); hamus of hind wing absent; prosternum medially subplanate, lacking a distinct posteriorly convergent carinate collar; mesosternum lacking anterior medial carina or tubercle, xyphus tumid; metasternum convex, posterior margin not produced over abdominal sternum 2.

Legs. fore femora unarmed on subapical, anterior margin of inferior surface; male with hind femora slender compared to fore and mid femora; subbasal inferior surface unarmed; subapical, inferior surface unarmed.

Abdomen. Abdominal sternum 2 medially simple; abdominal sternum 3 medially produced as a spine to mesosternal xyphus (Fig. 2D), ventrum of spine flat, dorsum of spine adpressed to, or narrowly separated from, metasternum (when adpressed, contacting transverse ridge of metasternum); intersegmental suture of abdominal sternum 2-3 terminating dorsoanteriorly on lateral margin of abdomen.

Male Genitalia. Pygophore with external opening posterior; aedeagal conjunctiva with a pair of sclerotised dorsolateral distal processes (latter fused medially at base), a pair of small membranous laterodistal processes, a pair of sclerotised ventrolateral proximal processes, each bearing 3-4 minute spines on ventral, proximal surface, and one sclerotised ventrolateral distal process with apex medially cleft and serrate (Fig. 3C-E); vesica sclerotised, tubular, joined dorsally to ventrolateral distal process (Fig. 3D,E).

Female Genitalia. Sclerotised first and second rami absent; spermathecal bulb spherical in profile; spermathecal duct between bulb and distal flange tubular, with two flanges, slender, with lateral duct leading to sac-like expansion (Fig. 2E).

REMARKS. *Tibiospina* may be confused with the rare oncomerine genus *Garceus*, with which it is sympatric in north Queensland. However *Garceus* lacks both the pronotal extension over the base of the scutellum and the highly modified male abdomen and legs. *Tibiospina* is included in a key to world oncomerine genera (Sinclair, 2000).

Tibiospina darlingtoni sp. nov.
(Figs 1, 2A-G, 3A-E)

ETYMOLOGY. In honour of the late P.J. Darlington Jnr, Harvard entomologist and biogeographer, who collected a specimen during his field work in Australia in 1957-58.

MATERIAL. Holotype, ♂, in QM (QMT62937). Label 1: NQ 10°31'S X 145°16'E, Mt. Lewis Rd, 29km from highway, 1100m, 23.xi.1998, C.R. Burwell; Label 2: Swept from roadside vegetation; genitalia undissected; Label 3: red holotype label with name handwritten by author. Paratype, ♂, in QM: Label 1: 145°30'E X 17°27'S, roadside adjacent to Mt. Hypipamee National Park, Atherton Tablelands, N. Qld, 10/12/1998, A. Rozefelds; Label 2: attracted to light from complex notophyll rainforest; Label 3: blue paratype label with name handwritten by author. Right fore leg from femur missing; left hind wing glued on card beneath specimen; genitalia dissected; pinned with fore and hind wings at right angles to body; colour of specimen very faded (pale brown yellow) when compared to holotype. ♀ in QM: NE Qld, 3.5km W of Cape Tribulation (Site 7), 20-23 iv 1983, 680m, G.B. Monteith, D.K. Yeates; left antennal segments 4, 5 missing; right antennal segments 1-5 carded beneath specimen; genitalia undissected. ♀ in AMNH. Label 1: Australia, Darlington; Label 2: Mt. Bellenden Ker, E. side, Q., 3-4500', xii 57, P.J. Darlington. Missing parts: left fore leg tarsal segments 2,3; right mid leg tarsal segments 2,3; left hind leg from femur onwards; left fore leg carded; genitalia dissected. ♀ in SAM. Label 1: Kuranda [145°35'E, 16°48'S] Queensland, F.P. Dodd; Label 2: Garceus fidelis Dist. (Musgrave's hand), Det. By A. Musgrave. Missing parts: left antennal segments 2 (from basal 1/3)-5; right antennal segments 4,5; left fore leg from femur onwards; left mid leg tarsal segments 2,3; right mid leg from trochanter onwards; right hind leg tarsal segments 2,3; mesosternum distorted by pin; genitalia dissected.

DESCRIPTION. MALE. Body length 17.0 (holotype)-17.5mm (paratype); dorsal view as in Fig. 2A.

Head (Fig. 2B). Moderately declivous (circa 45° to horizontal), smooth; antennae: segments 2-5 weakly depressed; segment 3 very short compared to segments 2, 4, and 5 (Fig. 2A); ratio of maximum antennal length to maximum body length 12:17 (holotype)-12:17.5 (paratype); bucculae subtriangular in profile; rostral apex terminating at, or slightly anterior to, mesosternal xyphus.

Thorax. Dorsum of pronotum, scutellum, propleuron and dorsal-most areas of meso- and metapleura irregularly punctate, latter concolourous with ground colour; hemelytra densely punctate, latter concolourous with hemelytra; remaining thoracic areas (and abdomen) smooth; pronotum: moderately declivous, anterolateral margins not produced, acute in cross section, weakly reflexed, entire; posterolateral angles produced slightly over hemelytral claval suture (Fig. 2A); scutellar disc weakly tumose basally, latter extending as obsolescent longitudinal carina to scutellar subapex (Fig. 2C).

Legs. Dorsal surfaces of tibiae weakly sulcate; tarsal segment 1 in dorsal view as wide as segment 3.

Abdomen. Margins of laterotergа 3-7 serrate; dorsal-most surface of abdominal sternum 3 spine apically free of thoracic mesosternum; trichobothrial pairs orientated parallel to intersegmental sutures, positioned dorsal to a line drawn through abdominal spiracles 3-7, commencing from abdominal sternum 3 the pairs becoming progressively closer to the abdominal spiracles (Fig. 2D); abdominal segment 8: concealed beneath abdominal sternum 7, tergite shorter medially than sternite, spiracle present.

Pygophore. Longer than high, internal opening anterior, profile in dorsal view as in Fig. 3A, in posterior view as in Fig. 3B; dorsal rim forming a pronounced, weakly arrow-shaped ridge medially, area anterior of the ridge weakly depressed; dorsal ridge extending postero-laterally to sub-apical area of pygophore, medially with a transverse area marking the dorsal-most part of a sub-vertical wall which extends ventrally and laterally to ventral rim; ventral rim immediately ventral and posterior to external opening of pygophore forming large dorsally and weakly posteriorly directed tongue-like process (apex of process medially incised), lateral basal margins of tongue enclosing base of parameres, ventral rim forming sharp, medially-directed ridge on dorsal-most half; prominent ledge present on pygophore wall lateral to base of paramere and slightly dorsal to ventral rim. *Proctiger*. Sclerotised, covering aedeagus dorsally, with pale, medial desclerotised line. *Genitalia*. Paramere (Fig. 2G) elongate, slightly recurved, with ventral, preapical angulate sclerotised lobe, a postero-laterally directed tooth at apical 2/3 of length joined by heavily sclerotised strip on lateral face to heavily sclerotised, sharp, produced apex; ventral and medial surfaces asetose; dorso-lateral face sparsely setose above heavily sclerotised strip; *in situ* parameres curved postero-laterally and dorsally from external opening of pygophore (Fig. 3B).

Colour (living specimens). Dorsum with brown-yellow, venter yellow-brown; ocelli red; apical quarter of antennal segment 5 yellow brown; antennae (excluding apical quarter of segment 5), vittae on pronotal dorsal submargin and hemelytra (areas submarginally over two triangular sclerites at base, medial of claval suture and slightly medial thence lateral of medial fracture to lateral margins and posteriorly to coriomembranal suture), tarsal segments 2,3

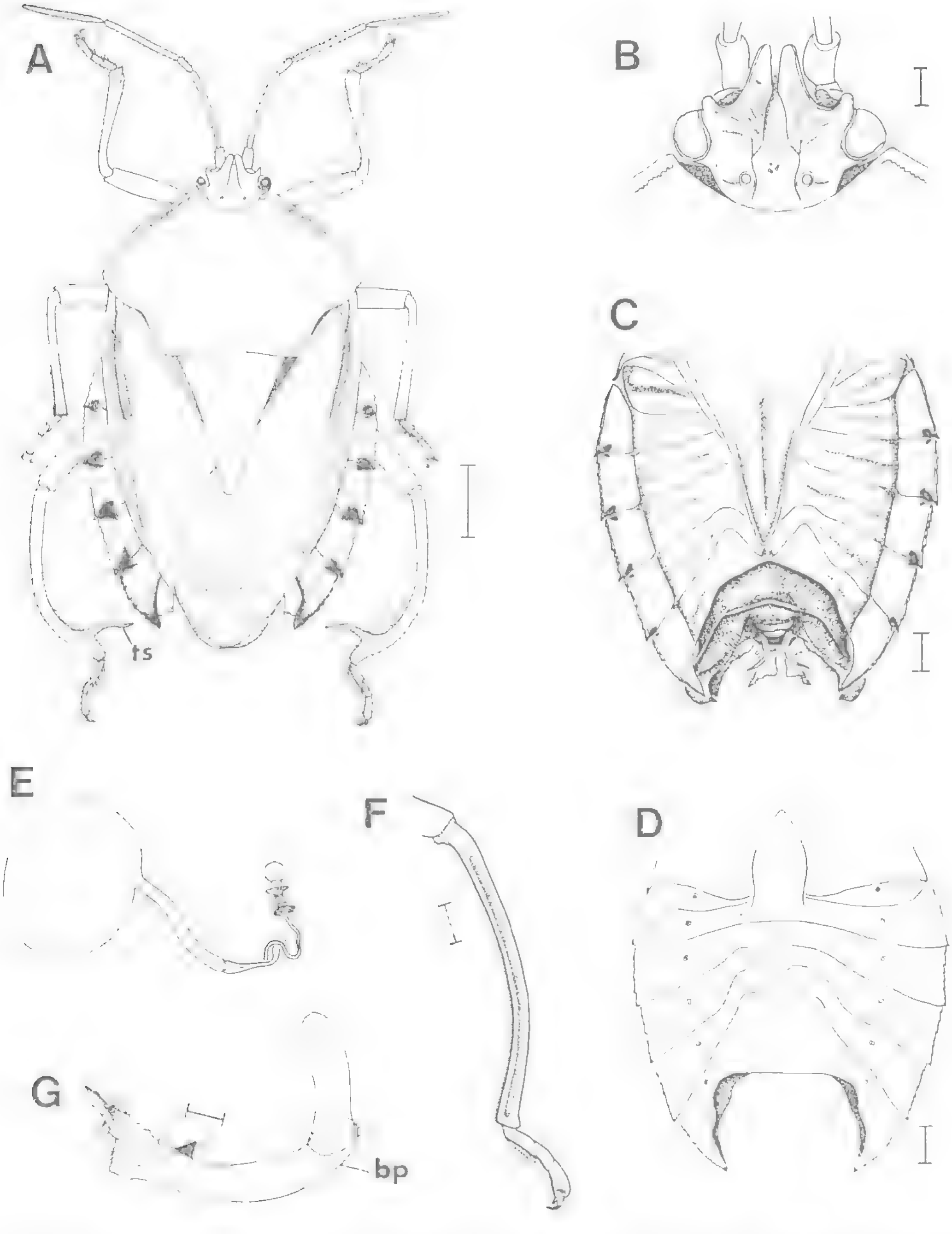

FIG. 2. *Tibiospina darlingtoni* sp. nov.; A, ♂, dorsal view; B, ♂, head, dorsal view; C, ♂, scutellum, abdomen, pygophore, dorsal view (wings removed); D, ♂, abdomen, ventral view (pygophore removed); E, spermatheca; F, ♀, hind tibia; G, left paramere, medial face. Scale bars: A = 2.48mm; B = 0.25mm; C = 0.61mm; D = 0.74mm; E = 0.99mm; F = 0.91mm; G = 0.25mm.

(excluding apical ½ of claws), dark brown with reddish tinge; exposed abdominal laterotergites 3-7 and legs (femur apically, tibia, tarsal segment 1), red-brown. Forewing membrane reflective. Apical ½ of claws, posterior angles of abdominal lateroterga 3-7, subquadrate transverse areas medial to and adjoining posterior angles of abdominal lateroterga 3-6, and small, narrow, subtriangular transverse areas on anterior sublateral angles of abdominal lateroterga 4-7, black (Fig. 2C).

FEMALE (Fig.1). As in male, except: body length 19-22mm; head: ratio of maximum antennal length to maximum body length not recorded; legs: apex of fore tibiae on medial side produced into tubercle (positioned dorsal to comb of antennal cleaning organ), tibial dorsal surfaces lightly sulcate; abdomen: margins of paraterga 8, 9 serrate; female genitalia: medial submargins of paraterga 9 and gonocoxae 1 depressed, gonocoxae 2 visible in ventral view ring sclerites well developed; colour: apex of fore and mid leg tibiae, apical half of hind leg tibiae, red-brown; paraterga 8, 9 black.

Subfamily TESSARATOMINAE Stål

Pseudosepina gen. nov.

TYPE SPECIES. *Pseudosepina longula* sp. nov.

ETYMOLOGY. Referring to its similarity to *Sepina*.

DIAGNOSIS. Body elongate, slender (Fig. 3F); first gonocoxae of female genitalia with distinctly incised posterior margin (Fig. 3I).

DESCRIPTION. *Head* (Fig. 3G). Wider than long; antennae at least three-segmented (segments missing apically); jugae medially seperated anterior to tylus; rostral segment 1 extending posteriorly beyond bucculae; rostral apex terminating at mesosternum.

Thorax. Membrane of forewing opaque; hind wing with A1 (= Pcu) stridulitrum; scutellum longer than wide, apex extending to abdominal tergum 4; prosternum medially weakly depressed basally, lacking a distinct posteriorly convergent carinate collar; mesosternum lacking a anterior medial tubercle or carina, xyphus raised as acute longitudinal carina; metasternum forming weakly elevated, convex carina, posterior margin not produced over abdominal sternum 2.

Abdomen. Medial area of abdominal sternum 2, 3 flat.

Female Genitalia. Paratergite 8 not expanded laterally compared to paratergite 9; medial margins of paratergite 9 contiguous, fused as one piece; sclerotised rami absent; spermathecal bulb nonspherical in profile, spermathecal duct between bulb and distal flange tubular, dilated along the majority of its length part below the proximal flange (Fig. 3H).

Male. Unknown.

REMARKS. This genus may be confused with the tessaratomine genus *Sepina*. However, *Sepina* has a shorter, broader body when viewed dorsally.

Pseudosepina longula sp. nov.
(Fig. 3F-I)

ETYMOLOGY. Specific name refers to the elongate nature of the body.

MATERIAL. Holotype ♀, in ZIL. Label 1: Madagascar, Tananarive (hand written in black ink). Label 2: Clermont, Vend. (hand-written in black ink). Missing parts: right and left antennal segments 4, 5; left mid leg tarsus; right hind leg tarsal segments 2, 3. Right hind wing slide mounted in Euparal. Detached rostrum and left antennal segments 2, 3 carded. Genitalia dissected.

DESCRIPTION. *Female*. Maximum body length 13.5mm; appearance in dorsal view as in Fig. 3F.

Head (Fig. 3G). Weakly declivous (approx. 20° to the horizontal) in profile; dorsum with punctate, wineglass shaped coloured area (punctures aconcolourous with wineglass shaped area); bucculae triangular in profile.

Thorax. Pronotum weakly declivous in profile; pronotum (except lateral margins, medial vitta), scutellum (except lateral margins, medial vitta), hemelytra (except lateral margins), punctate, punctures aconcolourous with body ground colour; thoracic propleuron, more dorsal areas of meso- and metapleura, irregularly punctate; pronotum: antero-lateral margins not produced, acute in cross section, reflexed, roughened by minute spine-bearing tubercles.

Legs. Fore coxae separated by a wide gap from mid and hind coxae; tibial dorsal surfaces planate, apical ventral surfaces armed with minute spines; tarsal segment 1 in dorsal view as wide as segment 3.

Abdomen. Tergum and ventral sternum areas above vittae irregularly punctate; lateral margins roughened by minute tubercles; female genitalia with long setae on medial submargins of paraterga 9.

Colour. Yellow with slight tinge of brown ground colour; punctures of head, pronotum, scutellum,

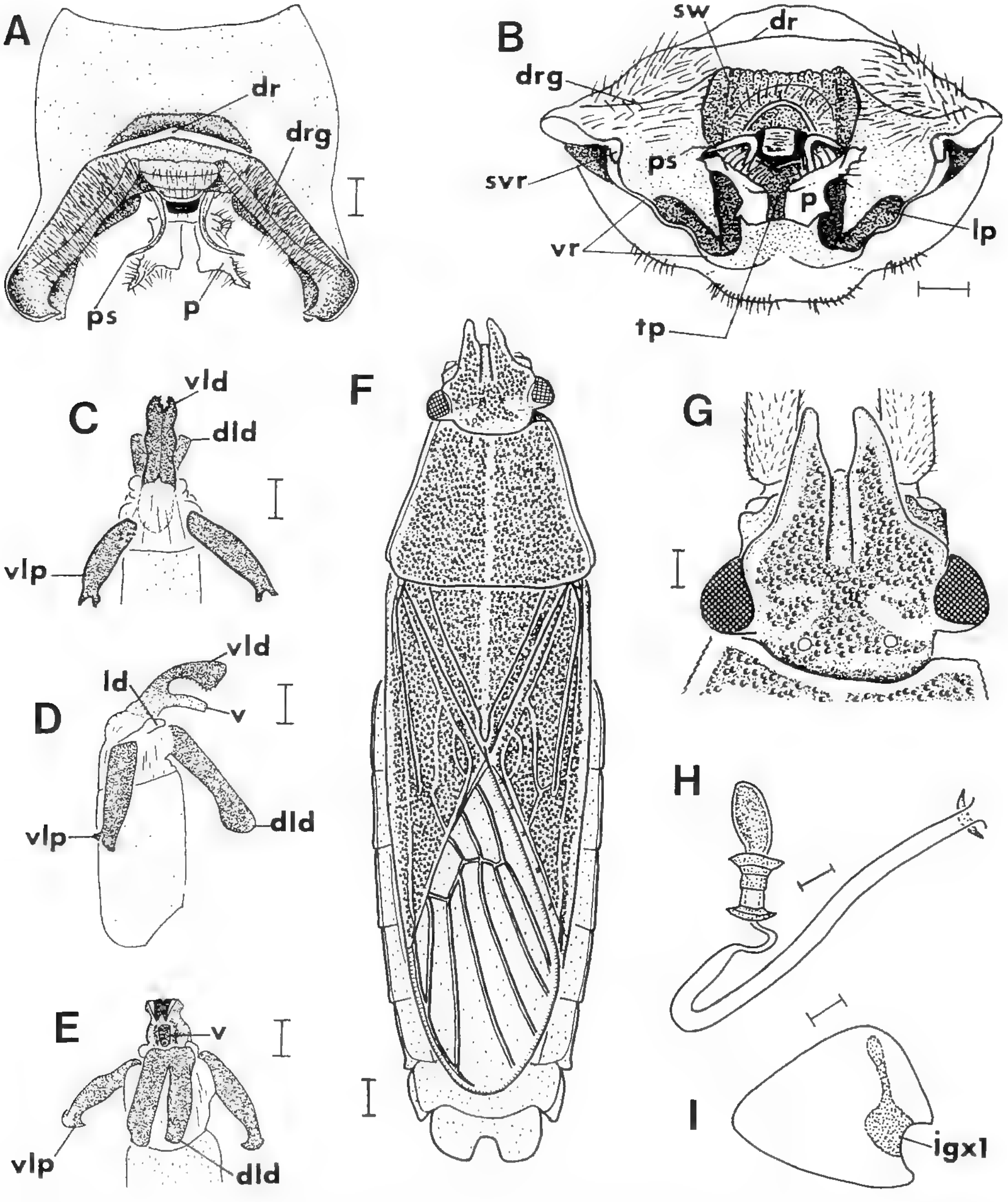

FIG. 3. A-E, *Tibiospina darlingtoni* sp. nov., ♂; A, pygophore, dorsal view; B, pygophore, posterior view; C, aedeagus (everted), ventral view; D, aedeagus (everted), lateral view; E, aedeagus (everted), dorsal view. F-I, *Pseudosepina longula* sp. nov., ♀; F, dorsal view; G, head, dorsal view; H, spermatheca; I, first gonocoxa. Scale bars: A = 0.37mm; B = 0.53mm; C,D,E = 0.25mm; F = 0.57mm; G = 0.28mm; H,I = 0.22mm.

hemelytra, and apical ¼ of pretarsal claws, dark brown-black; ventrum of body length with pair of dark brown-black, wide vittae, each vitta positioned on laterodorsal head area (on antennophore and immediately across and posterior to compound eye), laterodorsal thoracic pleural area (dorsal to ostiole of metathoracic scent gland), abdomen (ventral to imaginary line drawn through spiracles), narrowing across more dorsal area of gonocoxae 1, and terminating on ventral margins and submargins as semicircular area; apex of rostral segment 4 with dark brown spot; minute tibial spines black.

Male. Unknown.

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A GENERIC REVISION OF THE ONCOMERINAE (HETEROPTERA: PENTATOMOIDEA: TESSARATOMIDAE)

DAVID PATRICK SINCLAIR

Sinclair, D.P. 2000 12 31: A generic revision of the Oncomerinae (Heteroptera: Pentatomoidea: Tessaratomidae). *Memoirs of the Queensland Museum* **46**(1): 307-329. Brisbane. ISSN 0079-8835.

The fifteen accepted genera of the tessaratomid shield bug, subfamily Oncomerinae, are reviewed and a differential key provided. A new diagnosis of the subfamily is established. Generic redescriptions and illustrations of representative species are given for all genera except the newly described *Tibiospina* Sinclair. Distribution records and foodplants are summarised for each genus. All known species are listed. ❒ *Heteroptera, Tessaratomidae, Oncomerinae, generic key, host plants, genitalia, distribution, Australia.*

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The tessaratomid subfamily Oncomerinae Stål currently includes 15 genera and 57 species (Rolston et al., 1993; Sinclair, 2000) occurring predominantly in the Australian zoogeographic region (sensu Cranston & Nauman, 1991). Major publications on the subfamily subsequent to Stål, some of which include keys to the genera known at that time, include Horvath (1900b), Kirkaldy (1909), Leston (1955a), Leston & Scudder (1957) and Kumar (1969).

All of the 12 oncomerine genera that occur in Australia are confined to the eastern half of the continent, where most are restricted to the narrow, moist, northeastern, coastal belt which enjoys a tropical or subtropical climate. Within that zone there are three areas of diversity, each of which has about seven genera occurring more or less sympatrically. These areas are: i) the northern half of Cape York Peninsula; ii) the Wet Tropics zone between Cooktown and Townsville; and iii) the region comprising the SE corner of Queensland and the NE corner of New South Wales.

This paper redescribes 14 of the 15 genera currently included in the subfamily Oncomerinae; the remaining genus, *Tibiospina*, was recently described (Sinclair, 2000). Redescriptions are necessary as the majority of these genera were described in the nineteenth century. The generic redescriptions have required a redescription of the subfamily.

An interesting aspect of their little known biology is nymphal phoresy, which occurs in the females of at least three genera: *Cumare pallida* Blöte, *Peltocopta crassiventris* (Bergroth) (Monteith, 1998) and *Garceus fidelis* Distant (this paper).

MATERIALS AND METHODS

Specimens Examined. Wherever possible, at least five adult females and five adult males of each species listed under the generic descriptions were examined. Abbreviations: * = Type/s; P = photo.

Genitalia Preparation and Descriptions. Genital segments were cleared by immersion in boiling 10-15% potassium hydroxide for 5-30 minutes. After several washes in tap water the segments were dissected using fine jewellers forceps and micropins mounted on the apex of matchsticks. The aedeagus was teased into its fully everted state using fine jewellers forceps to grasp the basal plates of the aedeagal phallosoma, and another pair to grasp the base of the vesica inside the phallotheca. After examination in tap water or 70% alcohol the genitalia were stored in glycerine-filled microvials beneath the specimen. Descriptions of the fully everted male aedeagus were made viewing the aedeagus in profile while it lay on its side in the natural position. The terms 'distal' and 'proximal' conjunctival processes are applied in a relative sense following Kumar & Ghauri (1970). Descriptions of the spermatheca commence from the bulb-end of the duct.

Line Drawings. Line drawings were made using a camera lucida attached to a binocular microscope.

Systematic Descriptions. A diagnosis and description is given for the subfamily Oncomerinae and for each included genus within it (for *Tibiospina*, see Sinclair, 2000). Diagnostic characters are unique at the subfamily level (when compared to the two other tessaratomid subfamilies) or the generic level (when compared to other oncomerine genera).

Generic synonymies and homonymies were given by Rolston et al. (1993), and are not repeated here unless there are significant references omitted by those authors.

For each generic description: 1) body length is the maximum length from the jugal apex to the abdominal apex; 2) head width versus length is the maximum width across the lateral margins of the compound eye when compared to the distance from the jugal apex to an imaginary line drawn between the ocelli; 3) when sternum 2 is stated as being medially 'simple' the area is convex or ridge-like rather than being modified into a tubercle or spine; 4) when the intersegmental suture of abdominal sterna 2-3 terminates dorsolaterally on the lateral margin of the abdomen (e.g. Fig. 5C) the first (basalmost) laterotergite seen in a dorsal view of the abdominal tergum is laterotergite 2 (e.g. Fig. 5D). When the intersegmental suture of abdominal sterna 2-3 terminates dorsoanteriorly on the lateral margin of the abdomen (e.g. Fig. 5B) 'laterotergite 2' becomes sublateral in position, with the anterior margin of laterotergite 3 forming an angulate wedge lateral to it. Laterotergite 3 is thus the first (basalmost) abdominal laterotergite.

Food Plants. In the Biology section for each genus the higher botanical classification used for recorded foodplants follows Mabberley (1989). Some of the foodplant information is presented in Schaefer & Ahmad (1987).

SYSTEMATICS

Subfamily ONCOMERINAE Stål

TYPE GENUS. *Oncomeris* Laporte, 1832.

DIAGNOSIS. Base of hemelytral membrane with two or less basal cells (basal cells usually absent) (Figs 1, 2, 3, 4A,B); veins R+M and Cu of hindwing parallel and narrowly separated or contiguous on proximal 2/3 (Fig. 4D); paratergites 9 of female separated medially by proctiger (Fig. 5E).

DESCRIPTION. Body length 12-43mm.

Head. Preocular tubercle absent; antennal segment 2 rounded-prismatic in cross section; rostral apex reaching mesosternum or metasternum.

Thorax. Coriomembranal suture of fore wing concave-sinuate (Figs 1, 2, 3, 4A,B); hind wing lacking a A1 (= Pcu) stridulitrum; metathoracic scent gland ostiole with prominent spout on anterior margin (Fig. 5B,C); prosternum medially flat to weakly sulcate, if sulcate, never bounded laterally by posteriorly convergent, acutely to laminately produced carinae. *Legs*. Hind femora of male unarmed on subbasal inferior surface; tarsi 3-segmented.

Female genitalia. Paratergite 8 not or weakly expanded laterally compared to paratergite 9; spermathecal duct tubular between bulb and distal flange.

Male genitalia. Sternum 8 concealed by sternum 7; basal dorsal surface of ejaculatory reservoir unmodified; parameres when present uniramous, elongate.

REMARKS. Leston (1955a) divided the subfamily Oncomerinae into subtribes Piezosternaria (for the genus *Piezosternum*) and Oncomeraria (for all other oncomerine genera). This was based on the following characters. Piezosternaria: vesica long, flexible, coiled; metasternum produced forwards into a long, wide-based spine; Ethiopian and Neotropical. Oncomeraria: Vesica rigid or semi-rigid, not elongate and coiled; metasternum flat or swollen but never produced forwards; Oriental and Australasian. This division is not recognised here as the flexible vesica state found in *Piezosternum* also occurs in *Agapophyta* and *Neosalica*. A more appropriate division would be *Piezosternum* and *Neosalica* versus all remaining oncomerine genera, as the external opening of the male pygophore is situated dorsally in *Piezosternum* and *Neosalica* (e.g. Fig. 6D) and posteriorly in all other Oncomerinae (e.g. Fig. 6B,C).

KEY TO GENERA OF ONCOMERINAE

1. Pronotum produced posteriorly over scutellar base (e.g. Fig. 4A) 2
   Pronotum terminating at scutellar base 4
2. Metasternum with broad carina produced anteriorly and adpressed to mesosternum (Fig. 6G) . . . . *Piezosternum*
   Metasternum lacking broad carina or if broad carina present, not produced anteriorly 3
3. Pronotal lateral angles produced as acute spines (Fig. 4B) . . . . *Neosalica*
   Pronotal lateral angles roundly produced . . . . *Tibiospina* (see Sinclair, 2000)
4. Medial area of abdominal sternum 3 produced anteriorly as a distinct spine (e.g. Fig. 6E,H) 5
   Medial area of abdominal sternum 3 simple or tuberculate (e.g. Fig. 6F,G) 11

5. Apex of abdominal sternum 3 spine reaching metasternum; mesosternal xyphus produced posteriorly as a bifurcation (Fig. 6E) . . . . *Agapophyta*
Apex of abdominal sternum 3 spine reaching mesosternum or (occasionally) prosternum; mesosternal xyphus simple, tumid or carinate 6
6. Fore femora with a prominent spine on ventral subapical anterior margin 7
Fore femora unarmed on ventral subapical anterior margin. 8
7. Pronotal anterolateral margins produced as curved (in dorsal view), variably explanate processes (Fig. 3B); hind tibiae flattened (Fig. 4E) . . . . *Oncomeris*
Pronotal anterolateral margins not produced, sublinear (in dorsal view)(Fig. 3C); hind tibiae dilated subbasally on inner margins (Fig. 4F) . . . . *Plisthenes*
8. Ostiolar spout long when compared to distance from ostiole to dorsal extremity of ostiolar plate (Fig. 5B) . . . . *Garceus*
Ostiolar spout short when compared to distance from ostiole to dorsal extremity of ostiolar plate (Fig. 5C) 9
9. Abdomen in dorsal view with lateral margins highly convex at base (Fig. 1B); head longer than wide in dorsal view . . . . *Erga*
Abdomen in dorsal view with lateral margins weakly convex at base; head wider than long in dorsal view 10
10. Abdomen in dorsal view with lateral margins strongly tapered posteriorly (Fig. 3D) . . . . *Lyramorpha*
Abdomen in dorsal view with lateral margins weakly tapered posteriorly (Fig. 2D). . . . . *Tamolia*
11. Hind tibiae bearing two distinct 'teeth' on inner margins (Fig. 5A). . . . . *Rhoecus*
Hind tibiae unarmed on inner margins 12
12. Antennae 4-segmented; mesosternal xyphus bicarinate, sulcate medially . . . . *Stilida*
Antennae 5-segmented; mesosternal xyphus simple or longitudinally carinate. 13
13. Body distinctly flattened in cross section; anterolateral pronotal margins and abdominal lateral margins foliaceous (Fig. 1C). . . . . *Peltocopta*
Body flattened or biconvex in cross section; anterolateral pronotal margins and abdominal lateral margins acutely produced. 14
14. Rostral segment 1 enclosed by bucculae; scutellar apex reaching to abdominal tergite 5. . . . . *Cumare*
Rostral segment 1 surpassing bucculae posteriorly; scutellar apex reaching to abdominal tergite 4 . . . . *Musgraveia*

GENERIC DESCRIPTIONS

Agapophyta Guerin, 1831

TYPE SPECIES. *Agapophyta bipunctata* Guerin, 1831.

DIAGNOSIS. Apex of scutellum bifurcate (Fig. 1A); mesosternal xyphus produced posteriorly as a bifurcation, adpressed to metasternum laterally (Fig. 6E); posterior half of metasternum medially broadly sulcate to receive entire dorsal surface of third abdominal sternal spine (Fig. 6E); spermathecal duct below the proximal flange initially slender then variably dilated and coiled to its base (see Kumar, 1969: fig. 91).

DESCRIPTION. Body length 13-20mm; dorsal view (Fig. 1A).

Head. Wider than long; antennae 4-segmented, apex reaching scutellum; jugae medially contiguous anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching from abdominal terga 5-7; hamus of hind wing absent; mesosternum with anterior medial tubercle, xyphus broadly swollen, remainder as in diagnosis; metasternum tumid, posterior margin not produced over second abdominal sternum, remainder as in diagnosis.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly (e.g. Fig. 5B); sternum 2 medially simple; sternum 3 medially with apex of spine reaching metasternum.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb spherical in profile, spermathecal duct as in diagnosis.

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a mostly membranous tube; conjunctiva with at least one pair of mostly sclerotised latero-proximal processes (see Kumar, 1969: fig. 66).

INCLUDED SPECIES. *A. astridae* Schouteden, 1933, *♀; *A. aurantiaca* Blöte, 1945, *♂; *A. bipunctata* Guerin, 1831, ♂♀; *A. boschmai* Blöte, 1945, ♂♀; *A. distincta* Blöte, 1952, ♂; *A. occidentalis* Blöte, 1945, *♂,♂; *A. similis* Blöte, 1945, P; *A.* undescribed species, Mt Kaindi, Papua New Guinea ♂♀; *A. ustulata* Blöte, 1945, *♂♀, ♂♀; *A. vankampeni* Blöte, 1945, *♂, ♂♀; *A. viridula* Blöte, 1945.

DISTRIBUTION. Australia (Qld, as far south as Cardwell); New Guinea; Woodlark Island; Bismarck Archipelago (Duke of York Island, New Britain, New Ireland); Solomon Islands (Kei and Kilinailau Islands); Moluccas (Aru, Buru, Misool and Salawati Islands); Sulawesi; Sumatra; Java; Malay Peninsula (West Malaysia).

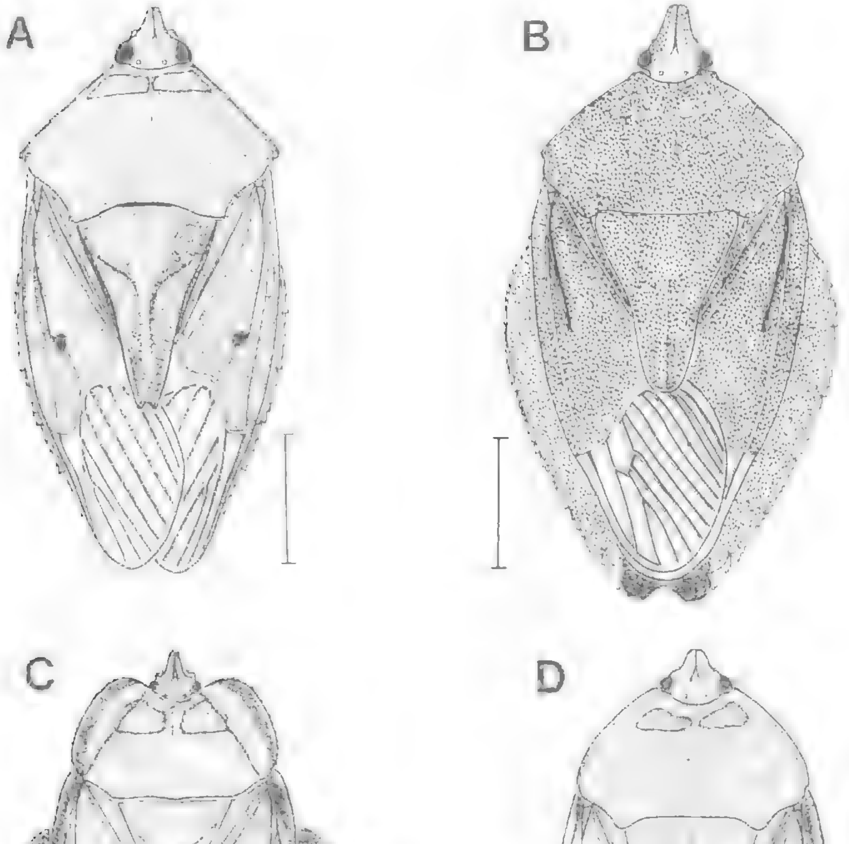

FIG. 1. Adults, dorsal view; A, *Agapophyta bipunctata* Guerin; B, *Erga longitudinalis* (Westwood); C, *Peltocopta crassiventris* (Bergroth); D, *Garceus fidelis* Distant. Scale bars: A = 3.98mm, B = 3.44mm, C = 6.66mm, D = 4.87mm.

Amyot & Serville (1843) listed *Agapophyta* from Tasmania (Australia). This record requires confirmation.

BIOLOGY. Foodplants. *A. bipunctata*: on shoots of *Cassia fistula* L. (Fabales: Leguminosae) (Kumar, 1969); on young leaves of *Cocos nucifera* L. (Arecales: Palmae) (Szent-Ivany & Catley, 1960); on leaves of *Hibiscus* sp. (Malvales: Malvaceae) (Mr W. Foung, pers. comm.); *A. boschmai* on pods *of Leucaena leucocephala* (Lam.) de Wit (syn. *L. glauca* Benth.) (Fabales: Leguminosae) (label data); an *Agapophyta* sp. on shoots, flower buds of

Cajanus cajan (L.) Millsp. (Fabales: Leguminosae) (Young, 1984).

REMARKS. Apart from an undescribed species from Mt Kaindi, Papua New Guinea, and occasional specimens of *A. vankampeni*, all remaining species of *Agapophyta* have a black spot at the apex of the forewing medial fracture (see Fig. 1A). A typographical error in Rolston et al. (1993) gives the year of description of *A. boschmai* as 1845. The correct date is 1945. Kumar (1969) labelled the male aedeagal conjunctival processes as being ventrolateral and proximal in position in *A. bipunctata*. These processes are actually lateroproximal in position

Cumare Blote, 1945

TYPE SPECIES. *Cumare pallida* Blöte, 1945.

DIAGNOSIS. Body flattened in cross section: rostral segment 1 enclosed by bucculae.

DESCRIPTION. Body length 12-19mm; dorsal view (Fig. 2 A).

Head. Wider than long; antennae 5-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum with anterior broad medial tubercle or tubercle absent; xyphus carinate to broadly carinate; metasternum swollen, with narrow medial longitudinal carina or carina absent; posterior margin not produced over second abdominal sternum, when produced reaching second abdominal sternum

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially forming noticeably convex ridge; sternum 3 medially with anterior conical tubercle pressing anteriorly under abdominal sternum 2.

Legs. fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami absent; spermathecal bulb spherical in profile, spermathecal duct below the proximal flange usually slender, with lateral duct leading to sac-like expansion (see Kumar, 1969: fig. 90).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a sclerotised tube of variable profile; conjunctiva with one pair of lightly sclerotised dorsolateral proximal processes; one pair of elongate, membranous, dorsolateral distal processes; one pair of membranous laterodistal processes (each process forming bifurcate lobes, one lobe directed towards phallosoma, other lobe away from phallosoma); one pair of elongate, lightly sclerotised ventrolateral distal processes (Fig. 6I) (see also Kumar, 1969: figs 60, 61).

INCLUDED SPECIES. *Cumare pallida* Blöte, 1945, [illegible]♀, ♂♀; *Cumare* undescribed species, Kiunga, Papua New Guinea, ♀.

DISTRIBUTION. Australia (Qld, as far south as Brisbane); Papua New Guinea (Kiunga; Daru Island).

BIOLOGY. Foodplants. *C. pallida* on *Petalostigma* sp. (Euphorbiales: Euphorbiaceae) (G.B. Monteith, pers. comm.; label data).

REMARKS. The undescribed species from Kiunga is noticeably larger than *C. pallida*.

Erga Walker, 1868

TYPE SPECIES. *Erga longitudinalis* (Westwood, 1837a).

DIAGNOSIS. Dorsally, abdomen with lateral margins highly convex basally (Fig. 1B); spermathecal duct below proximal flange initially slender then distally dilated, latter subsequently narrowed as proximal dilation to base of duct (see Kumar, 1969: fig. 86); aedeagal conjunctiva of male with one pair of mostly sclerotised ventrolateral proximal processes (Fig. 7G)

DESCRIPTION. Body length 12-15.5mm; dorsal view (Fig. 1B)

Head. Longer than wide; antennae 5-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum lacking anterior medial carina or tubercle, xyphus swollen with medial groove; metasternum swollen, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 medially with apex of spine reaching mesosternum.

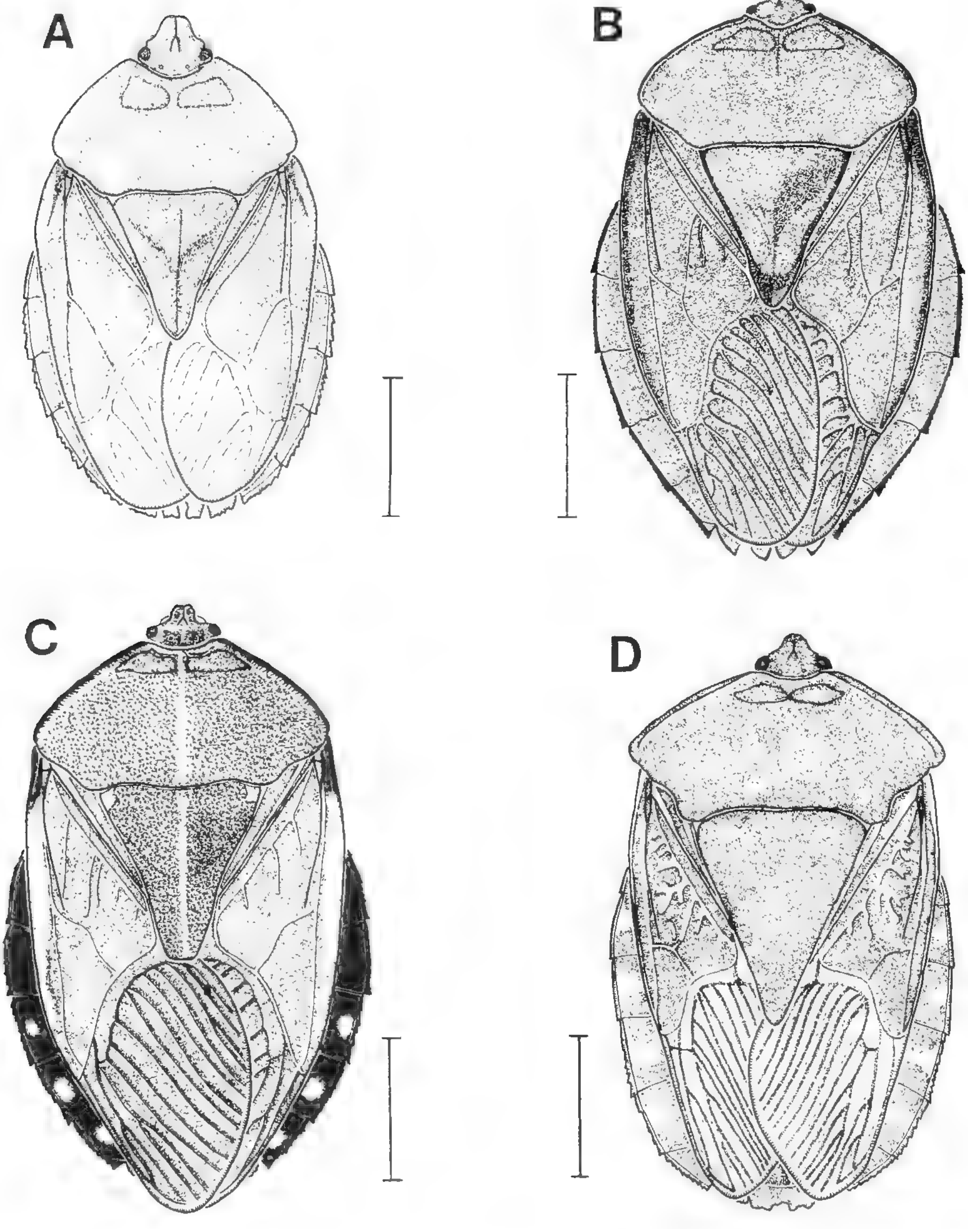

FIG. 2. Adults, dorsal view; A, *Cumare pallida* Blöte; B, *Stilida indecora* Stål; C, *Musgraveia sulciventris* (Stål); D, *Tamolia* sp. Scale bars: A = 4.37mm, B = 6.46mm, C = 5.88mm, D = 6.08mm.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb non-spherical in profile, spermathecal duct as in diagnosis.

Male Genitalia. Pygophore, external opening posterior in position; aedeagus: vesica forming a

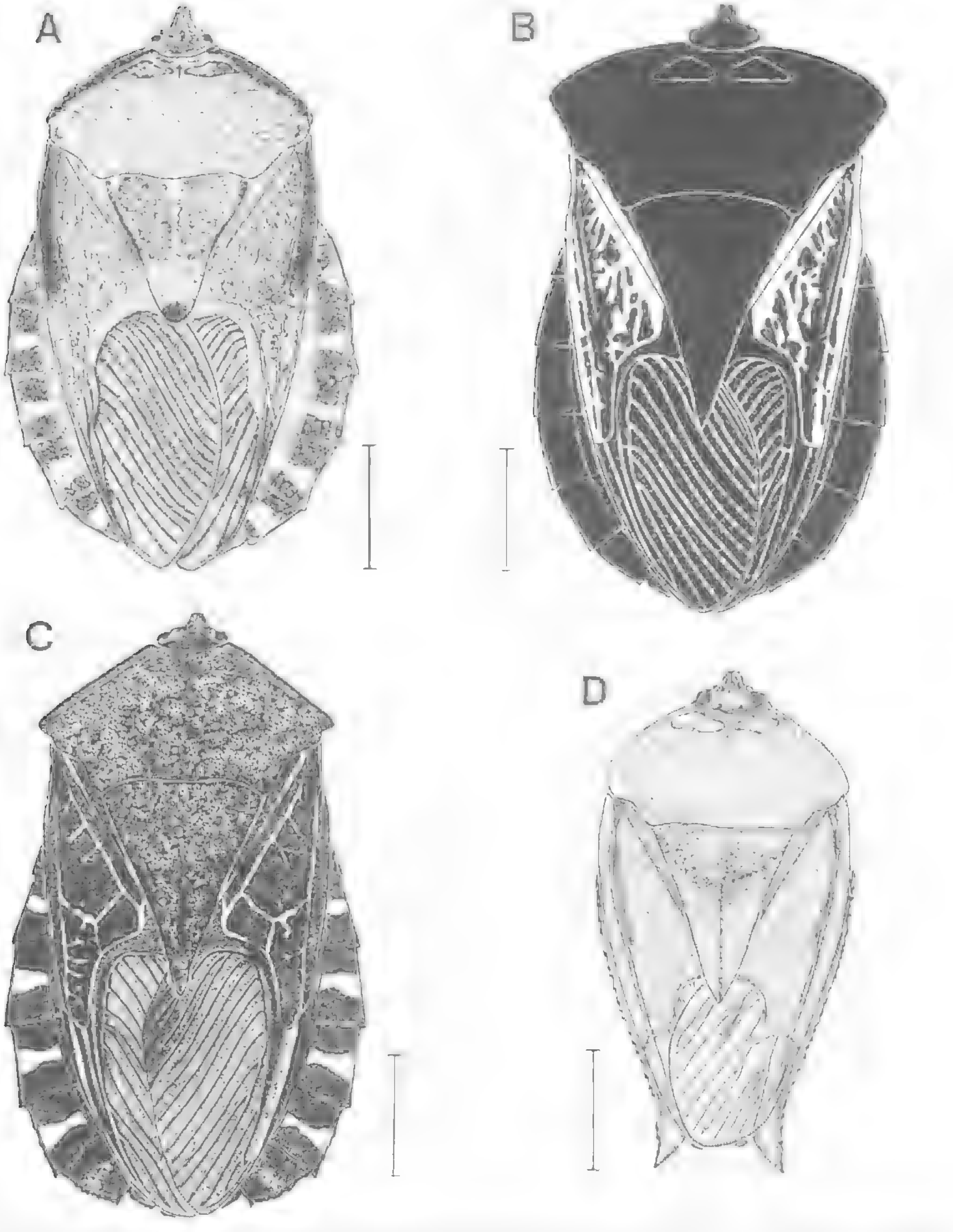

FIG. 3. Adults, dorsal view; A, *Rhoecus australasiae* (Westwood); B, *Oncomeris* sp.; C, *Plisthenes merianae* (Fabricius); D, *Lyramorpha rosea* Westwood. Scale bars: A = 7.39mm, B = 6.90mm, C = 7.21mm, D = 5.34mm.

sclerotised tube of variable profile; aedeagal conjunctiva with: one pair of membranous dorsomedial distal process; one pair of membranous ventrolateral distal processes (Fig. 7G), remainder as in diagnosis (see also Kumar, 1969: fig. 43).

INCLUDED SPECIES. *Erga longitudinalis* Westwood, 1837, *♀, ♂♀.

DISTRIBUTION. Australia (Qld, NSW). Records from Tasmania and 'New Guinea' require confirmation (see also Gross, 1975: 79).

BIOLOGY. The biology of *E. longitudinalis* is briefly discussed by Kumar (1969). Foodplants: *E. longitudinalis* on shoots of *Austrosteenisia blackii* (F.Muell.) R.Geesink (syn. *Lonchocarpus blackii* F. Muell.) (Fabales: Leguminosae) (Kumar, 1969).

REMARKS. This genus may be confused with the genus *Agapophyta* (Fig. 1A).

Garceus Distant, 1893

TYPE SPECIES. *Garceus fidelis* Distant, 1893.

DIAGNOSIS. Body weakly flattened in cross section; ostiolar spout long when compared to distance from ostiole to dorsal extremity of ostiolar plate (Fig. 5B).

DESCRIPTION. Body length: 17-22mm; dorsal view (Fig. 1D).

Head. Wider than long; antennae 5-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum with anterior medial carina; xyphus broad, swollen; metasternum weakly convex, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 simple medially; sternum 3 medially with apex of spine reaching mesosternum.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami absent; spermathecal bulb spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (Fig. 6A).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a sclerotised tube of variable profile; conjunctiva with: one pair of small dorsolateral distal processes; one pair of lightly sclerotised lateroproximal processes; one pair of large, membranous laterodistal processes; one pair of lightly sclerotised ventrolateral proximal processes (Fig. 7H).

INCLUDED SPECIES. *Garceus fidelis* Distant, 1893, ♂♀.

DISTRIBUTION. Australia (Wet Tropics area, N Qld). A record from Peak Downs in the semi-arid inland near Clermont requires confirmation.

BIOLOGY. The biology and foodplants of the genus are unknown. Four large dead nymphs were found adhered to the basal, ventral surface of the abdomen in a dead pinned female from the NMNH collected in the early 1900s by J.F. Illingworth at Babinda in N Queensland. These four nymphs were separated from the female and stored in an associated plastic vial.

Lyramorpha Westwood, 1837a

TYPE SPECIES. *Lyramorpha rosea* Westwood, 1837a.

DIAGNOSIS. Dorsally, abdomen in dorsal view with lateral margins strongly tapered posteriorly (Fig. 3D).

DESCRIPTION. Body length16.5-30mm; dorsal view (Fig. 3D).

Head. Wider than long; antennae usually 5-segmented (4-segmented in *L. rosea*), apex reaching scutellum; jugae usually contiguous medially anterior to tylus; rostral apex usually reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching from abdominal terga 5-6; hamus of hind wing absent; mesosternum with anterior medial tubercle, xyphus swollen; metasternum convex, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 medially with apex of spine reaching mesosternum.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami usually absent (present in *L.rosea*); spermathecal bulb usually spherical in profile (non-spherical in *L. maculifera*); spermathecal duct below proximal flange slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: figs 82, 83, 84).

Male genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a

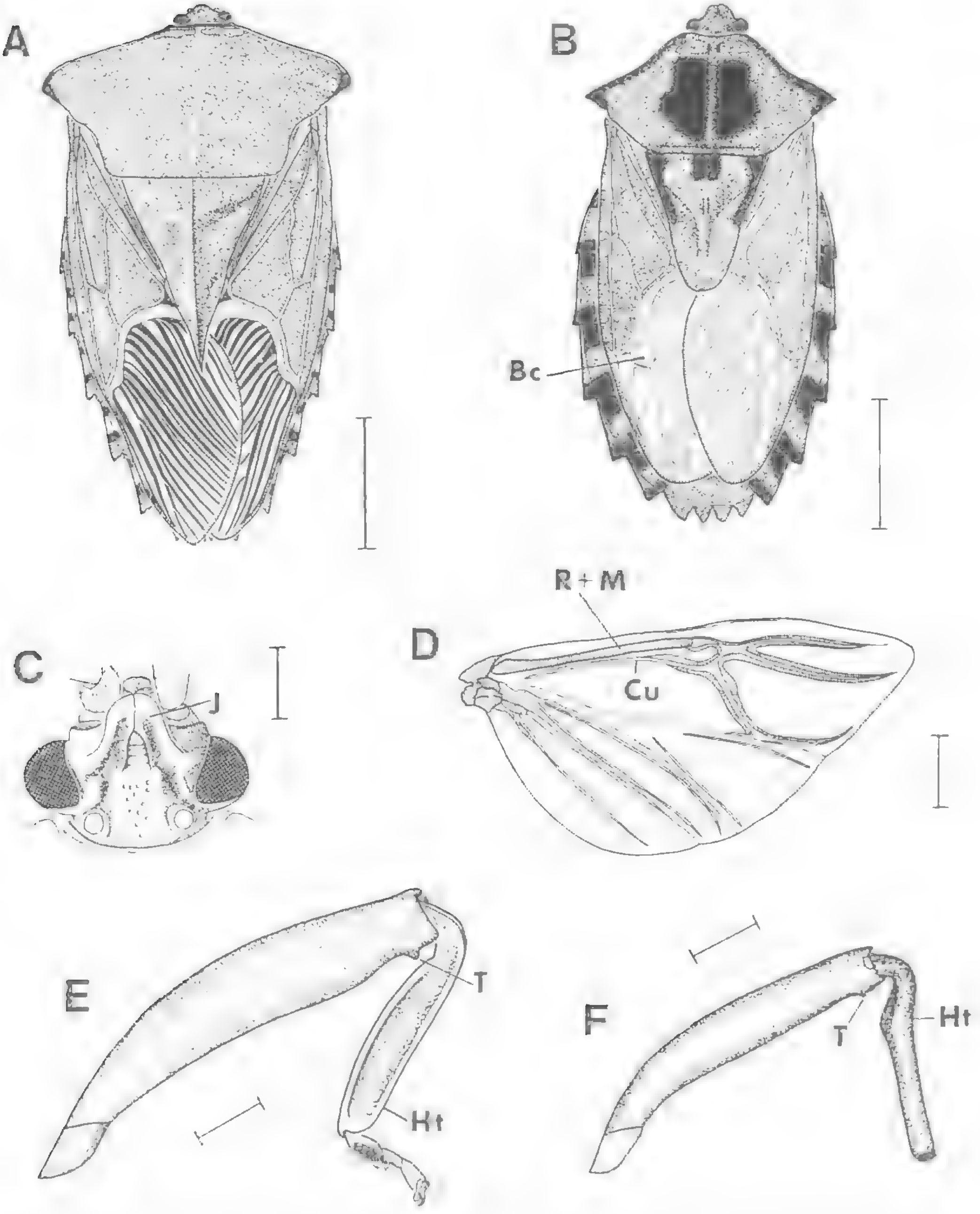

FIG. 4. A,B, Adults, dorsal view; A, *Piezosternum subulatum* (Thunberg); B, *Neosalica pedistris* (Breddin). C, *Piezosternum subulatum*, head, dorsal view. D, *Tamolia* sp., right hindwing, dorsal view. E,F, left hindleg, ventral view; E, *Oncomeris* sp.; F. *Plisthenes dilatatus* (Montrouzier). Abbreviations: Bc, basal cell; Cu, vein Cu; Ht, hindtibia; J, jugum; R+M, veins R and M; T, tooth. Scale bars: A = 5.33mm, B = 5.00mm, C = 0.78mm, D = 2.40mm, E = 3.42mm, F = 3.70mm.

sclerotised tube of variable profile. Conjunctiva: usually lacking one pair of basally medially fused, apically bifurcate, sclerotised dorsomedial distal process (present in *L. brongersmai* (Fig. 7D,E) and *L. maculifera*); usually with two pairs of variably sclerotised dorsolateral distal processes (e.g. Fig. 7C,D,E) (one pair present in *L. impar*, *L. soror* and *L. edulis* (Fig. 7A,B)); one pair of usually basally bifurcate, at least lightly sclerotised, lateroproximal processes present (e.g. Fig. 7C) (one arm of each process situated ventrolaterally, distally in *L. edulis* [Fig. 7A,B]) (processes uniramous in *L. brongersmai* (Fig. 7D) and *L. maculifera*).

INCLUDED SPECIES. Subgenus *Diploxiphus*; *L. brongersmai* Blöte, 1952, *♂♀, ♂♀; *L. horvathi* Blöte, 1952, *♂♀; *L. maculifer* Tryon, 1892, ♂♀; Subgenus *Lyramorpha*; *L. rosea* Westwood, 1837a, *♂, ♂♀; Subgenus *Lyrodes*; *L. ambigua* Horvath, 1900a, ♀; *L. basalis* Horvath, 1900b, *♀; *L. breddini* Horvath, 1900a, ♂♀; *L. diluta* Stål, 1863, ♂♀; *L. edulis* Blöte, 1952, *♂♀, ♂♀; *L. impar* Horvath, 1900a, ♂; *L. parens* Breddin, 1900, ♂♀; *L. persimilis* Horvath, 1900a, ♂♀; *L. picta* Distant, 1893; *L. plagifer* Blöte, 1952, *♂♀; *L. soror* Breddin, 1900, ♂♀; *L. vollenhoveni* Stål, 1867, ♂♀; Incertae sedis; *L. perelegans* Vollenhoven, 1868, *♂♀, ♂♀.

DISTRIBUTION. Australia (Qld, NSW); New Guinea (including Fakfak and Yule Islands); Moluccas (Aru, Bachan, Halmahera, Morotai, Waigeo and Salawati Islands); Sulawesi; Malay Peninsula (West Malaysia). Australian records from Victoria and South Australia require confirmation.

BIOLOGY. The biology of *L. rosea* is briefly discussed by Kumar (1969). Foodplants: *L. rosea* on: *Cupaniopsis anacardioides* (A. Rich.) Radlk. (Kumar, 1969); *Alectryon excelsum* Gaertn. (label data); shoots of *Guioa semiglauca* (F.Muell.) Radlk. (this paper); *Litchi* sp. (label data). All plants belong to the Sapindales: Sapindaceae.

REMARKS. The abdominal disc is often suffused with metallic blue, green and purple colours.

Musgraveia Leston & Scudder, 1957

Musgravea McDonald, 1966: 59 (incorrect subsequent spelling).

TYPE SPECIES. *Musgraveia sulciventris* (Stål, 1863).

DIAGNOSIS. Abdominal sterna medially longitudinally bicarinate (particularly towards abdominal apex) (flat in females of *M. sulciventris*).

DESCRIPTION. Body length 17.5-24.5mm; dorsal view (Fig. 2C).

Head. Wider than long; antennae 5-segmented, apex reaching hemelytral membrane; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum as wide as long to longer than wide, apex reaching abdominal tergum 4; hamus of hind wing absent (*M. sulciventris*) or present (*M. antennatus*); mesosternum lacking anterior medial carina or tubercle, xyphus flat, broad; metasternum swollen, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 medially with anterior tubercle.

Legs. fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface bearing a tubercle.

Female Genitalia. Sclerotised rami present (*M. sulciventris*) or absent (*M. antennatus*); spermathecal bulb non-spherical in profile, spermathecal duct below the proximal flange usually slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: figs 80, 81).

Male Genitalia. Pygophore: external opening posterior in position; aedeagus: vesica forming a sclerotised tube of variable profile; conjunctiva: *M. sulciventris*: one pair of very large membranous dorsoproximal processes (latter fused medially for majority of length, each process with ventrally-directed lobe); one pair of mostly sclerotised, apically-bifurcate, membranous, dorsomedial distal processes (see Kumar, 1969: figs 25, 26, 27, here refigured [Fig. 7I,J]); *M. antennatus*: one pair of long, sclerotised dorsolateral distal processes; one pair of lightly sclerotised lateroproximal processes (Fig. 8A) (see also Kumar, 1969: fig. 29).

INCLUDED SPECIES. *M. antennatus* Distant, 1880, ♂♀; *M. sulciventris* Stål, 1863, ♂♀.

DISTRIBUTION. Papua New Guinea (Mabu Duan); Australia (Qld, NSW, as far south as Wollongong).

BIOLOGY. The biology of *M. sulciventris* has been well studied as it is a minor economic pest

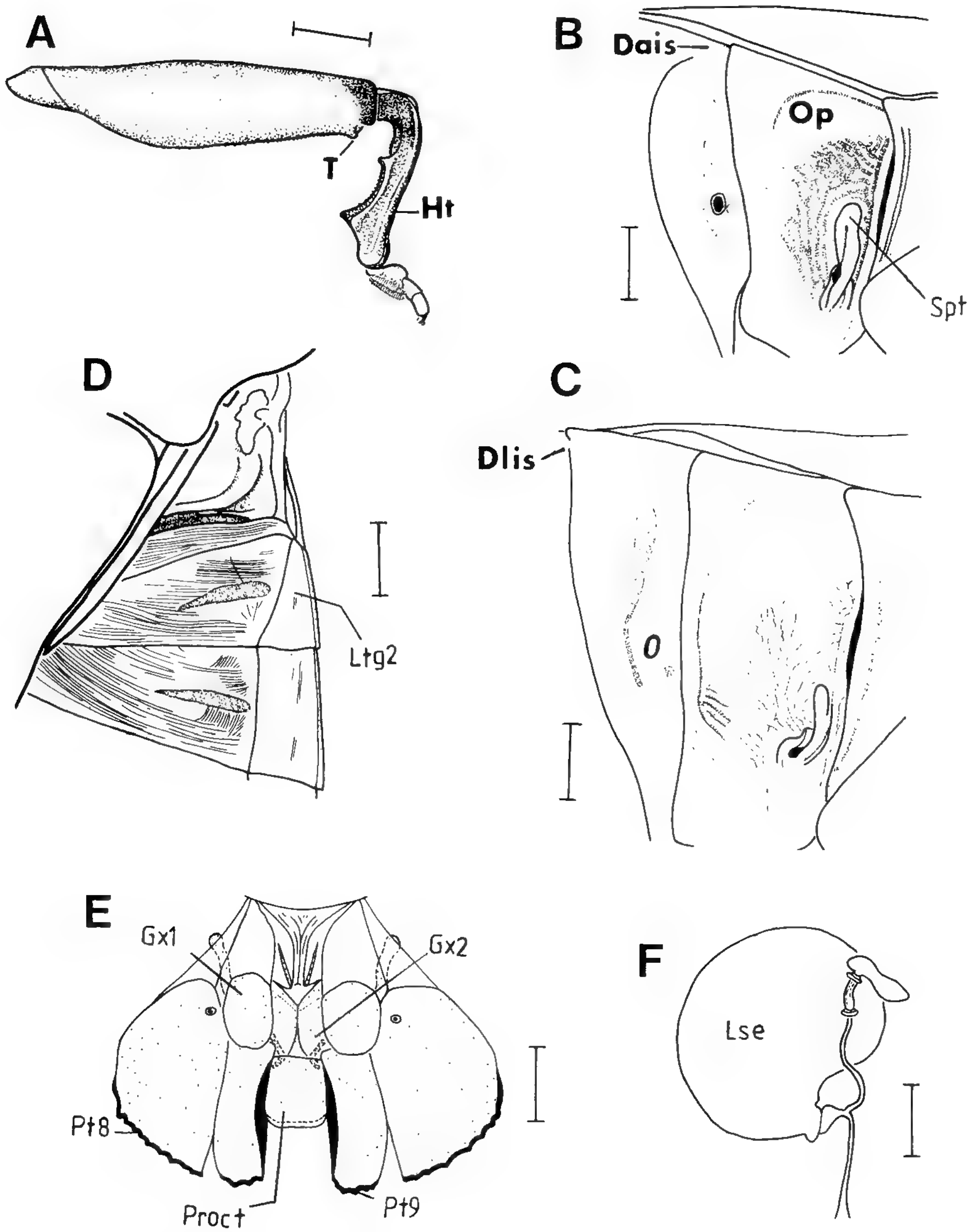

FIG. 5. A, *Rhoecus australasiae*, left hindleg, ventral view. B,C, right side of body, area surrounding ostiole of metathoracic scent gland; B, *Garceus fidelis*; C, *Tamolia* sp. D, *Tamolia* sp., dorsal view, right side of thorax-abdomen junction. E, *Garceus fidelis*, ventral view, external ♀ genitalia, (abdominal segments 8,9 removed from abdomen). F, *Tamolia*, sp., Spermatheca. Abbreviations: Dais, dorsoanterior termination of intersegmental suture of abdominal sterna 2-3; Dlis, dorsolateral termination of intersegmental suture of abdominal sterna 2-3; Gx1, gonocoxa 1; Gx2, gonocoxa 2; Ht, hindtibia; Lse, lateral sac-like expansion of spermathecal duct; Ltg2, laterotergite 2; Op, ostiolar plate; Pt8, paratergite 8; Pt9, paratergite 9; Proct, proctiger; Spt, spout; T, tooth; Scale bars: A = 4.00mm, B = 1.07mm, C = 1.15mm, D = 1.50mm, E = 1.00mm, F = 0.78mm.

on cultivated citrus. Major articles include, *inter alia*, Froggatt (1901, 1907), Girault (1924), Hely (1938, 1944, 1964, 1968), Hely et al. (1982), McDonald (1969), Olliff (1892), Summerville (1935), Smith (1983), Tryon (1889, 1923a,b,c) and Veitch & Simmonds (1929). Foodplants: *M. sulciventris* on: leaf nodules, petioles, flower pedicles, fruit, shoots of *Citrus glauca* (Lindl.) Burkill [syn. *Eremocitrus glauca* (Lindl.) Swingle] (Hely, 1968); *Citrus australis* (A. Cunn. ex Mudie) Planch. [syn. *Microcitrus australis* (A. Cunn. ex Mudie)] (Summerville, 1935); *Citrus australasica* F.Muell. [syn. *Microcitrus australasica* (F. Muell.) Swingle] (Tryon, 1923a); *Citrus aurantium* L. (Kirkaldy, 1909); *Citrus limon* Burm. f. (Kirkaldy, 1909). *M. antennatus* on *Citrus aurantifolia* Swingle (label data). All plant records above are from the Sapindales: Rutaceae.

Neosalica Distant, 1882

TYPE SPECIES. *Neosalica pedestris* Distant, 1882.

DIAGNOSIS. Pronotal lateral angles produced laterally as acute spines (Fig. 4B); mesosternal xyphus tumid, with transverse carina extending around periphery between furcal pits (Fig. 6F); gonopore of male aedeagal ejaculatory duct situated on dorsal surface of vesica (see Kumar, 1969: fig. 77, here refigured [Fig. 8I]); spermathecal bulb of female genitalia elongate, weakly coiled apically (see Kumar, 1969: fig. 93); spermathecal duct below proximal flange initially slender then distally dilated, latter long and convoluted, subsequently slender followed by proximal dilation at base of duct (see Kumar, 1969: fig. 93).

DESCRIPTION. Body length 19.5-26mm; dorsal view (Fig. 4B) (see also Leston, 1955b: fig. 6).

Head. Wider than long; antennae 5-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin produced over scutellar base; scutellum longer than wide, apex reaching abdominal tergum 4; hamus of hind wing present; mesosternum with anterior medial carina, xyphus as in diagnosis; metasternum carinate, narrowed apex, and basal angles, weakly produced, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 medially with obsolescent broadly truncate tubercle.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb as in diagnosis; spermathecal duct as in diagnosis.

Male Genitalia. Pygophore, external opening dorsal in position; aedeagus, vesica forming a mostly membranous tube; conjunctiva with: one pair of elongate, membranous, dorsolateral distal processes; one pair of mainly sclerotised lateroproximal processes; one sclerotised, bulbous ventromedial distal process (Fig. 8I).

INCLUDED SPECIES. *N. forbesi* Distant, 1882, *♂; *N. pedestris* Breddin, 1902, *♂♀.

DISTRIBUTION. China (Yunnan), India (North India, Sikkim), Korea, Myanmar, Vietnam, Sumatra.

BIOLOGY. Biology and foodplants unknown.

Oncomeris Laporte, 1832

TYPE SPECIES. *Oncomeris flavicornis* (Guerin, 1831)

DIAGNOSIS. Hind tibiae flattened (Fig. 4E); one pair of 'teeth' present on dorsal rim of male pygophore above base of proctiger (one on each side of latter) (Fig. 6B); body with dark brown-black ground colour and hemelytra often with variable shades of orange to red-brown.

DESCRIPTION. Body length 22-43mm; dorsal view (Fig. 3B).

Head. Wider than long; antennae 4-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum lacking an anterior medial carina or tubercle; xyphus swollen; metasternum convex, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsolaterally (Fig. 5C); sternum 2 medially simple; sternum 3 medially with apex of spine usually reaching mesosternum (occasionally to prosternum).

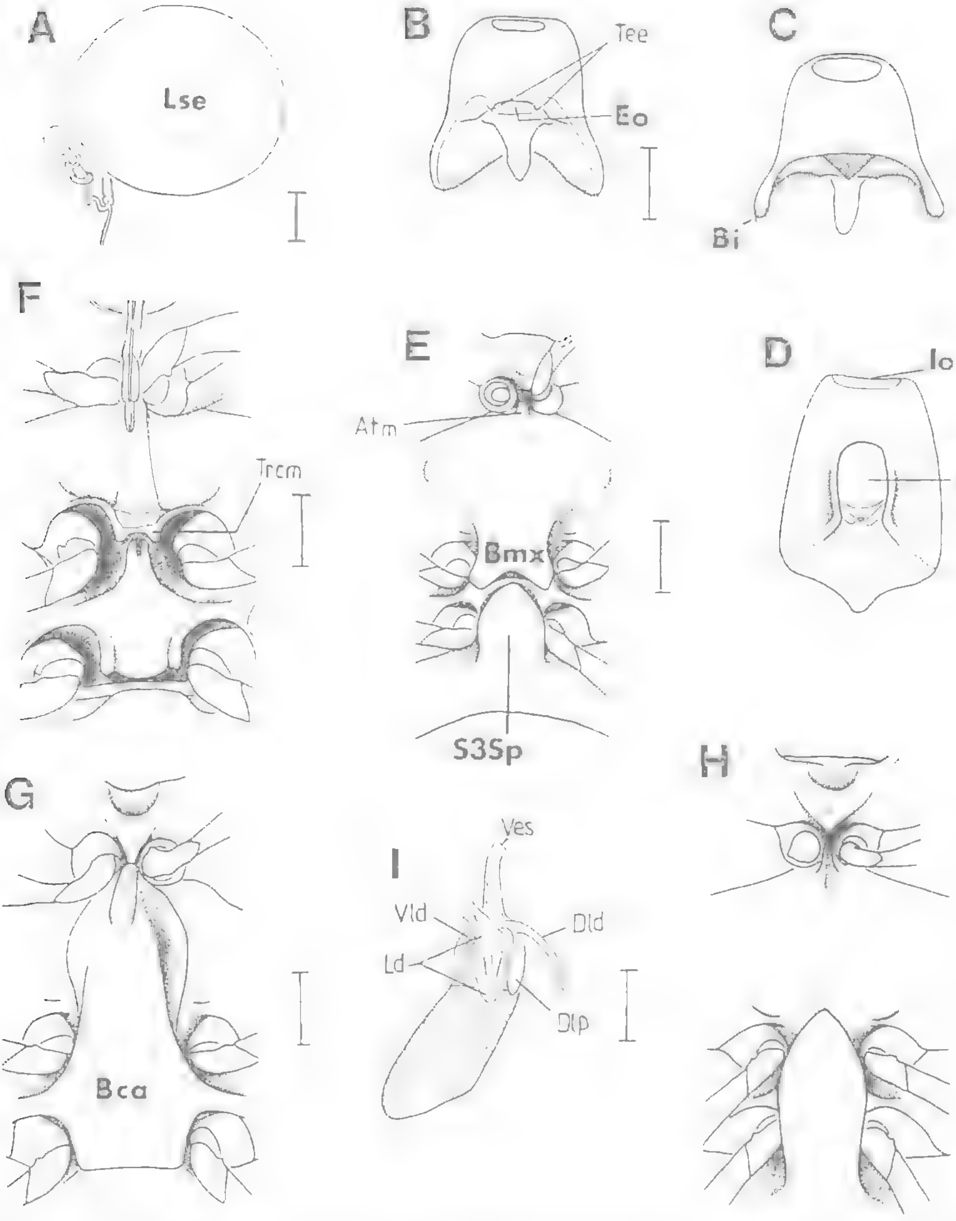

FIG. 6. A, *Garceus fidelis*, spermatheca. B-D, ♂ pygophore, dorsal view; B, *Oncomeris flavicornis* (Guerin); C, *Plisthenes scutellatus* distant; D, *Neosalica pedestris*. E-H, thoracic sterna and basal abdominal segments, ventral view; E, *Agapophyta bipunctata* Guerin; F, *Neosalica forbesi* Distant; G, *Piezosternum subulatum*; H, *Garceus fidelis*. I, *Cumare pallida*, aedeagus, lateral view, right side. Abbreviations: Atm, anterior mesosternal tubercle; Bca, broad metasternal carina; Bi, bifurcation of mesosternal xyphus; Bmx, bifurcation of mesosternal xyphus; Dld, dorsolateral distal conjunctival process; Dlp, dorsolateral proximal conjunctival process; Eo, external opening of pygophore; Io, internal opening of pygophore; Ld, laterodistal conjunctival process; Lse, lateral sac-like expansion of spermatheca; S3sp, spine of abdominal sternum 3; Tee, teeth; Trcm, transverse mesosternal carina; Ves, vesica; Vld, ventrolateral distal conjunctival process. Scale bars: A = 0.78mm, B = 2.70mm, C = 2.00mm, D, E = 1.50mm, F = 1.90mm, G = 1.38mm, H = 1.18mm, I = 0.39mm.

Legs. Fore femora on subapical, anterior margin of inferior surface armed with a prominent spine; hind femora of male incrassate when compared to mid and hind femora, subapical inferior surface bearing a tubercle (Fig. 4E).

Female Genitalia. Sclerotised rami present; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: fig. 87).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a mostly sclerotised tube of variable profile; conjunctiva with: one pair of sclerotised, dorsolateral proximal processes; one pair of elongate, sclerotised, apically membranous, dorsolateral distal processes; one pair of sclerotised ventromedial processes (Fig. 8G,H) (see also Kumar, 1969: figs 46, 47).

INCLUDED SPECIES. *O. bernsteinii* Vollenhoven, 1868, ♂♀; *O. chrysoptera* Vollenhoven, 1868, ♂♀; *O. flavicornis* Guerin, 1831, ♂♀; *O. ostraciopterum* Montrouzier, 1855, ♂♀; *O. vicinus* Horvath, 1900a, ♂♀.

DISTRIBUTION. Australia (Qld, as far south as Babinda), Bismarck Archipelago (New Britain, New Ireland), Java, Borneo, Sumatra, Solomon Islands, Lesser Sunda Islands (Timor Island), Moluccas (Aru, Buru, Halmahera, Morotai, Ternate, Waigeo Islands), New Guinea (Woodlark Island), Sulawesi. One record from New Caledonia requires confirmation.

BIOLOGY. Foodplants: *O. flavicornis* on *Dracontomelon mangiferum* Blume (Sapindales: Anacardiaceae) (Mr G.F. Gross, SAM, pers. comm.); an *Oncomeris* sp. on young leafy shoots *of Cassia nodosa* Buch.-Ham. Ex Roxb. and *C. javanica* L. (Fabales: Leguminosae) (label data).

Peltocopta Bergroth, 1904

TYPE SPECIES. *Peltocopta crassiventris* (Bergroth, 1895).

DIAGNOSIS. Body distinctly flattened in cross section; anterolateral pronotal and abdominal lateral margins foliaceous (Fig. 1C); jugae elongate, horn-like (see Leston, 1955a: fig. 2); mesosternum: with anterior medial transverse carina; abdominal segment 7 encircling genital segments; male parameres absent (possibly functionally replaced by distinctive pygophoral hypandrial processes – see Leston, 1955a: fig. 5 and Kumar, 1969: fig. 41); paratergite 9 of female projecting ventral to paratergite 8 when viewed dorsally.

DESCRIPTION. Body length 20.5-26.5mm; dorsal view (Fig. 1C) (see also Leston, 1955a: fig. 1).

Head. Longer than wide; antennae 5-segmented, apex reaching hemelytral membrane; jugae contiguous medially or separated anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum usually wider than long (occasionally as wide as long), apex reaching abdominal tergum 4; hamus of hind wing absent; mesosternum lacking anterior medial carina or tubercle, .xyphus flat, with obsolescent thin longitudinal carina; metasternum tumid, with narrow medial longitudinal carina (see Leston, 1955b: fig. 3), posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 medially with broad, weakly elevated tubercle pressing anteriorly into posterior margin of sternum 2.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami absent; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: fig. 85).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a sclerotised tube of variable profile; conjunctiva with: one pair of short, mostly lightly sclerotised laterodistal processes; one pair of long, sclerotised ventrolateral distal processes (Fig. 7F) (see also Kumar, 1969: fig. 40).

INCLUDED SPECIES. *Peltocopta crassiventris* Bergroth, 1895, ♂♀.

DISTRIBUTION. Australia (S Qld, N NSW).

BIOLOGY. Foodplants: *P. crassiventris* on *Mallotus discolor* F. Muell. ex Benth. (Euphorbiales: Euphorbiaceae) (Kumar, 1969).

REMARKS. Specimens of this genus are known from a very limited number of sites. The specimens found in many institute collections originate from a foodplant growing in the grounds of the Chevron Hotel, Surfers Paradise,

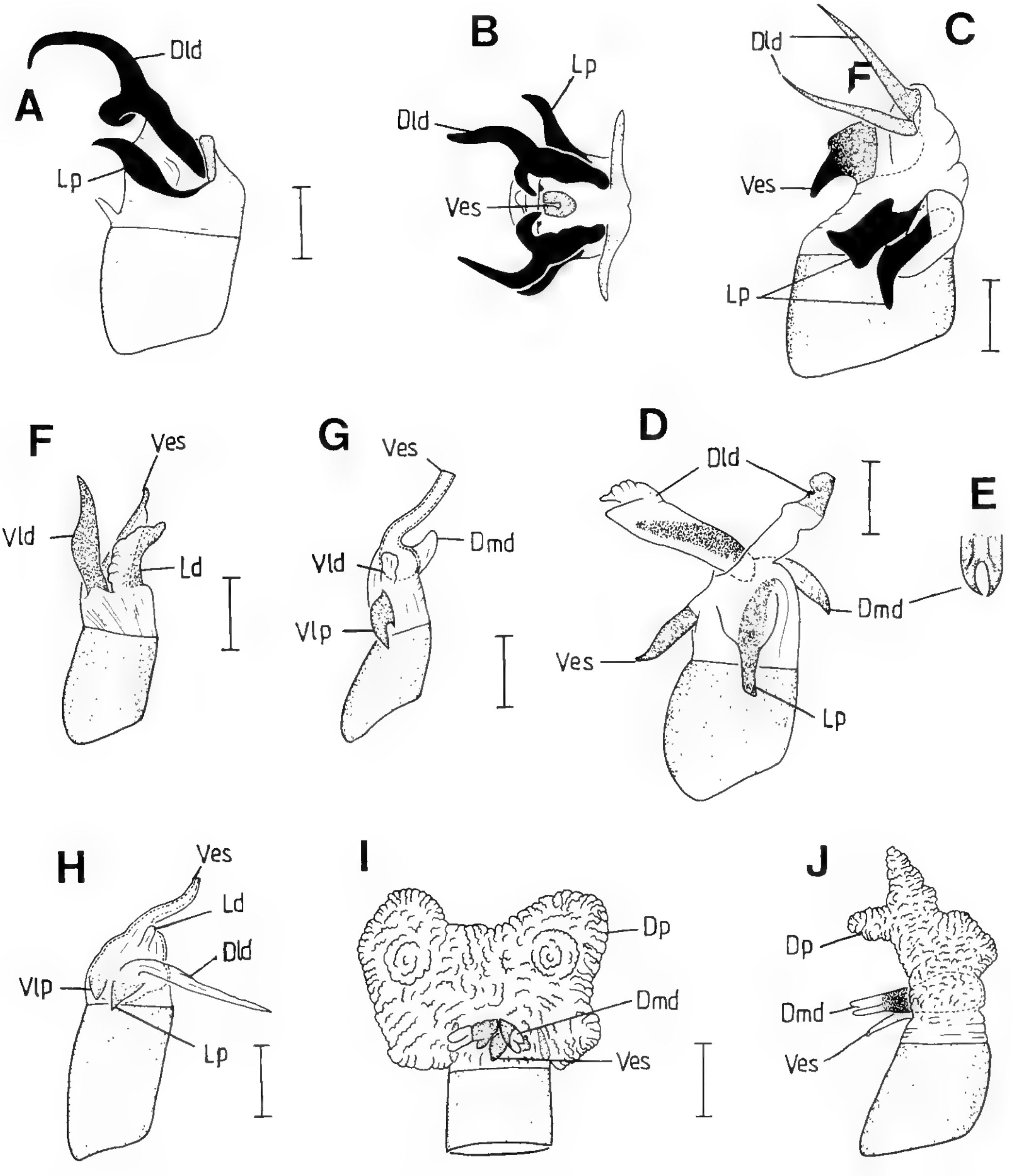

FIG. 7. A-J, aedeagus, lateral view, right side except apical view for B, dorsal view of dorsomedial distal conjunctival process for E, ventral view for I; A,B, *Lyramorpha edulis* Blöte; C, *L.parens* Breddin; D,E, *L.brongersmai* Blöte; F, *Peltocopta crassiventris*; G, *Erga longitudinalis*; H, *Garceus fidelis*; I,J, *Musgraveia sulciventris* (after Kumar, 1969). Abbreviations: conjunctival processes: Dld, dorsolateral distal; Dmd, dorsomedial distal; Dp, dorsoproximal; Ld, laterodistal; Lp, lateroproximal; Vld, ventrolateral distal; Vlp, ventrolateral proximal. Ves, vesica. Scale bars: A,B = 1.00mm, C-G = 0.78mm, H = 0.39mm, I,J = 0.95mm.

southern Queensland about 1964, prior to the site being levelled for construction of a new hotel.

Piezosternum Amyot & Serville, 1843

TYPE SPECIES. *Piezosternum subulatum* (Thunberg, 1783).

DIAGNOSIS. Jugae of head short (Fig. 4C); metasternum with elevated broad carina, latter produced anteriorly as a compressed raised wedge and adpressed to mesosternum (Fig. 6G); spermathecal duct below proximal flange initially slender then usually dilated to base of duct (duct slender basally in *P. calidum*) (see Kumar, 1969: fig. 92).

DESCRIPTION. Body length16-24mm; dorsal view (Fig. 4A).

Head. Wider than long; antennae 5-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin produced over scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum with anterior medial tubercle, xyphus flat; metasternum: posterior margin produced over second abdominal sternum, touching tubercle of third abdominal sternum, remainder as in diagnosis.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 medially simple; sternum 3 with weakly produced, broadly conical, anterior medial tubercle.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb usually spherical in profile (non-spherical in *P. calidum, P. fallax*), spermathecal duct as in diagnosis.

Male Genitalia. Pygophore, external opening dorsal in position. aedeagus, vesica forming a mostly membranous tube; conjunctiva with: one pair of usually lightly sclerotised dorsolateral distal processes (inner-most lobe membranous in *P. depressum, P. subulatum* [Fig. 8J] and *P. thunbergi*); one pair of sclerotised lateroproximal processes; usually lacking one pair of membranous ventrolateral distal processes [present in *P. calidum* (Fig. 9A) (see also Kumar, 1969: fig. 70); usually lacking one elongate, sclerotised ventromedial distal process (present in *P. fallax* [Fig. 9B] [see also Kumar, 1969: fig. 74] and *P. rubens*).

INCLUDED SPECIES. Subgenus *Piezosternum*; *P. subulatum* (Thunberg, 1783), *♀, ♂♀; *P. thunbergi* Stål, 1860, *♂♀, ♂♀; Subgenus *Piezosternias*; *P. calidum* (Fabricius, 1787), ♂♀; *P. calidum breddini* Schouteden, 1905; *P. fallax* Breddin, 1898, ♂♀; *P. rubens* Distant, 1879, ♂♀; *P. venezolanum* Piran, 1971. Undescribed specimens with label bearing the following names: *P. depressum* Van Duzee, ♂; *P. geminatum* Van Duzee, ♀.

DISTRIBUTION. *Central and South America*: Argentina, Bolivia, Brazil, Cape Verde Islands, Colombia, Cuba, Ecuador, French.Guiana, Guyana, Hispaniola, Lesser Antilles (Guadeloupe, Martinique Islands), Mexico, Panama, Paraguay, Puerto Rico, Surinam, Uruguay, Venezuela, West Indies. *Africa*: Angola, Cameroon, Central African Republic, Congo, Gabon, Ghana, Equatorial Guinea, Guinea, Ivory Coast, Kenya, Madagascar, Malawi, Nigeria, Ruanda, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Zaire, Zanzibar, Zimbabwe. *Southern India.*

BIOLOGY. Biology of *P. calidum* is discussed by Goodchild (1967) and Goodchild & Lubega (1968). In this species the midgut gastric caecal bacteria are thought to assist in nutrition of the insect (Goodchild, 1978). Foodplants: *P. calidum*: feed on leaves (first, second instars) and stems (third instar to adult) of *Telfairia pedata* (Sm.) Hook. (Violales: Cucurbitaceae (Goodchild, 1967; Goodchild & Lubega, 1968); on *Momordica cissoides* Planch. ex Benth. and *M. foetida* Schum. (Violales: Cucurbitaceae) (Leston, 1955b); on stem, especially fruit, of *Sterculia cinerea* A. Rich. (Malvales: Sterculiaceae) (Mayne & Ghesquiere, 1934); on stem, especially fruit, of *Theobroma cacao* L. (Malvales: Sterculiaceae) (Mayne & Ghesquiere, 1934). *P. fallax* on: stem, especially fruit, of *Sterculia cineria* (Malvales: Sterculiaceae) (Mayne & Ghesquiere, 1934); stem, especially fruit, of *Theobroma cacao* (Malvales: Sterculiaceae) (Mayne & Ghesquiere, 1934).

REMARKS. In most species of this genus the anterolateral pronotal margins are not produced. However, they are produced as an acute spine in *P. subulatum.*

Plisthenes Stål, 1864

TYPE SPECIES. *Plisthenes merianae* (Fabricius, 1775).

DIAGNOSIS. Hind tibiae dilated subbasally on inner margins (Fig. 4F); posterior margin of male pygophore produced as a pair of narrow bifurcations (Fig. 6C); lateral jugal margins,

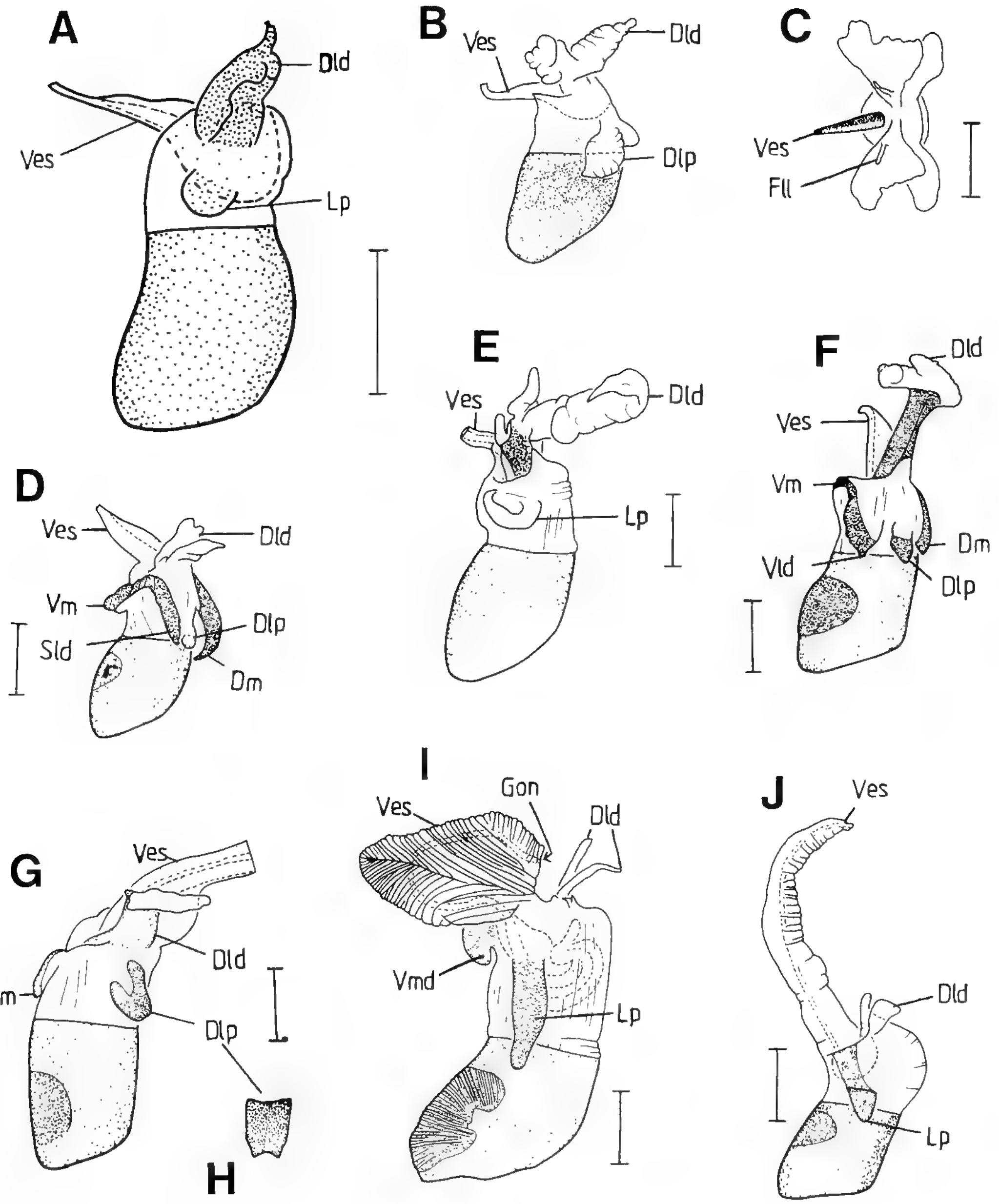

FIG. 8. A-J, aedeagus, lateral view, right side except apical view for C, ventral view of ventromedial conjunctival process for H; A, *Musgraveia antennatus* (Distant); B,C, *Stilida sinuata* Stål; D, *Tamolia* sp.; E, *Rhoecus australasiae*; F, *Plisthenes merianae*; G,H, *Oncomeris flavicornis*; I, *Neosalica forbesi* (after Kumar, 1969); J, *Piezosternum subulatum*. Abbreviations: conjunctival processes: Dld, dorsolateral distal; Dlp, dorsolateral proximal; Dm, dorsomedial; Lp, lateroproximal; Sld, sublaterodistal; Vm, ventromedial; Vmd, ventromedial distal. Fii, finger-like lobe of dorsolateral distal process; Gon, gonopore. Ves, vesica. Scale bars: A,B = 0.78mm, C = 0.80mm, D = 0.78mm, E = 1.34mm, F = 1.17mm, G,H = 1.05mm, I = 0.78mm, J = 1.18mm.

inner margin of eyes, ring surrounding ocelli, pronotal anterolateral submargins and anterior margin, reticulate fore wing veins and transverse vittae medially on abdominal lateroterga usually yellow brown, ground colour of body dark brown-black.

DESCRIPTION. Body length 22-39.5mm; dorsal view (Fig. 3C).

Head. Wider than long; antennae 4-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum lacking an anterior medial carina or tubercle; xyphus broadly swollen; metasternum convex, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsolaterally; sternum 2 medially simple; sternum 3 medially with apex of spine reaching mesosternum.

Legs. Fore femora on subapical, anterior margin of inferior surface armed with a prominent spine; hind femora of male incrassate when compared to mid and hind femora, subapical inferior surface bearing a tubercle (Fig. 4F).

Female Genitalia. Sclerotised rami absent; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: fig. 88).

Male. Pygophore, external opening posterior in position; aedeagus, vesica forming a mostly sclerotised tube of variable profile; conjunctiva with: one pair of sclerotised dorsomedial processes; one pair of sclerotised dorsolateral proximal processes; one pair of elongate, sclerotised, apically membranous, dorsolateral distal processes; one pair of sclerotised, ventrolateral distal processes, latter joined by variably sclerotised strip to one pair of variably sclerotised ventromedial processes (Fig. 8F) (see also Kumar, 1969: fig. 50).

INCLUDED SPECIES. *P. australis* Horvath, 1900a, ♂♀; *P. buruensis* Breddin, 1904; *P. confusus* Horvath, 1900a, ♂♀; *P. dilatatum* (Montrouzier, 1855), *♂♀, ♂♀; *P. merianae* (Fabricius, 1775), *♂, ♂♀; *P. moluccanus* Horvath, 1900a, *♂; *P. scutellatus* Distant, 1889, ♂♀.

DISTRIBUTION. Australia (Qld, as far south as Byfield State Forest, 40km N of Yeppoon), New Guinea (D'Entrecasteaux, Goodenough and Woodlark Islands), Bismarck Archipelago (New Britain, New Ireland), Solomon Islands (Bougainville; Guadalcanal, Haruku and Obi Islands); Tokelau (Atafu Island), Borneo, Java, Sulawesi, Moluccas (Amboina, Aru, Bachan, Buru, Ceram, Halmahera, Misool, Morotai, Salawati and Waigeo Islands), Sumatra, Lesser Sunda Islands (Timor Island), Malay Peninsula (West Malaysia).

BIOLOGY. Foodplants: a *Plisthenes* sp. on *Citrus* sp. (Sapindales: Rutaceae) (M. DeBaar, Queensland Forest Service, pers. comm.).

Rhoecus Bergroth, 1891

TYPE SPECIES. *Rhoecus australasiae* (Westwood, 1837b).

DIAGNOSIS. Hind tibiae bearing two 'teeth' on inner margins (Fig. 5A).

DESCRIPTION. Body length: 26-32.5mm; dorsal view (Fig. 3A).

Head. Wider than long; antennae 5-segmented, apex reaching hemelytral membrane; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum wider than long to as wide as long, apex reaching abdominal tergum 4; hamus of hind wing absent; mesosternum with anterior medial carina, xyphus carinate; metasternum tumid, with weakly developed medial longitudinal carina on anterior half, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsolaterally; sternum 2 medially weakly tumid; sternum 3 with anterior medial subspinose tubercle.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male incrassate when compared to mid and hind femora, subapical inferior surface bearing a tubercle (Fig. 5A).

Female Genitalia. Sclerotised rami present; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: fig. 89).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a

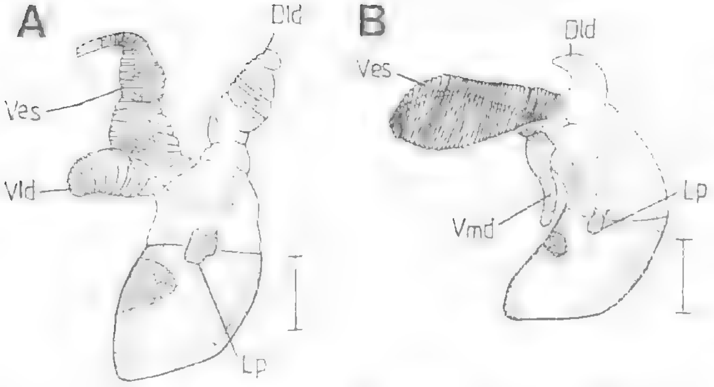

FIG. 9. A,B, aedeagus, lateral view, right side: A, *Piezosternum calidum* (Fabricius); B, *P. fallax* Breddin. Abbreviations: conjunctival processes: Dld, dorsolateral distal; Lp, lateroproximal; Vld, ventrolateral distal; Vmd, ventromedial distal. Ves, vesica. Scale bars: A, B = 0.78mm.

sclerotised tube of variable profile; conjunctiva with: one pair of mostly membranous dorsolateral distal processes (each process trilobate); one pair of smaller, membranous lateroproximal processes (each process bilobate) (Fig. 8E) (see also Kumar, 1969, fig. 56).

INCLUDED SPECIES. *Rhoecus australasiae* (Westwood, 1837b), *♂, ♀♂.

DISTRIBUTION. Australia (Queensland, New South Wales). A record from Victoria requires confirmation.

BIOLOGY. Foodplants: *R. australasiae* on *Melicope micrococca* (F. Muell.) T.G. Hartley (syn. *Euodia micrococca* F. Muell.) (Sapindales: Rutaceae) (G.B. Monteith, pers. comm.).

REMARKS. This genus is more commonly known as *Rhoecocoris* Bergroth (1895). Bergroth chose that name over the preexisting *Rhoecus* Bergroth (1891) because he considered *Rhoecus* Bergroth (1891) to be preoccupied by *Roicus* Clark, 1860. However, Rolston et. al.(1993: 55) point out that those names 'are similar but not identical and therefore not homonyms'. As *Rhoecus* Bergroth (1891) validly pre-dates *Rhoecocoris* Bergroth (1895) its name has priority.

Stilida Stål, 1863

TYPE SPECIES. *Stilida indecora* Stål, 1863.

DIAGNOSIS. Spermathecal duct of female genitalia entering and leaving spermathecal diverticulum at separate points (see Kumar, 1969: fig. 79); inner surface of male aedeagal dorsolateral distal conjunctival processes bearing one short, finger-like, stout lobe subbasally (Fig. 8C).

DESCRIPTION. Body length 20-28mm; dorsal view (Fig. 2B).

Head. Wider than long; antennae 4-segmented, apex reaching scutellum; jugae contiguous medially, or separated, anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum with weakly developed anterior medial tubercle, xyphus bicarinate, weakly sulcate medially; metasternum swollen, ventral surface mostly flat, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsoanteriorly; sternum 2 simple medially; sternum 3 with obsolescent anterior medial tubercle.

Legs. Fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (see Kumar, 1969: fig. 79).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a sclerotised tube of variable profile; conjunctiva with: one pair of lightly sclerotised dorsolateral proximal processes; one pair of lightly sclerotised dorsolateral distal processes, each process with diagnostic character state above (Fig. 8B,C) (see also Kumar, 1969: fig. 21).

INCLUDED SPECIES. *S. indecora* Stål, 1863 ♂♀; *S. sinuata* Stål, 1870 *♂, ♂♀.

DISTRIBUTION. Australia (Qld; NSW, as far south as Dalmorton).

BIOLOGY. The biology of *S. indecora* Stål is briefly discussed in Kumar (1969). Foodplants:

S. indecora on *Arytera* sp. and *Cupaniopsis parvifolia* (F.M.Bailey) L.A.S. Johnston (Sapindales: Sapindaceae) (G.B. Monteith, pers. comm.).

REMARKS. This genus may be confused with the genus *Musgraveia* (Fig. 2C).

Tamolia Horvath, 1900a

TYPE SPECIES. *Tamolia ramifera* (Walker, 1868).

DIAGNOSIS. Male aedeagal vesica with one pair of sclerotised sublaterodistal processes (joined by sclerotised strip to ventromedial processes) (Fig. 8D).

DESCRIPTION. Body length 18-24.5mm; dorsal view (Fig. 2D).

Head. Wider than long; antennae 4-segmented, apex reaching scutellum; jugae contiguous medially anterior to tylus; rostral apex reaching mesosternum.

Thorax. Posterior pronotal margin terminating at scutellar base; scutellum longer than wide, apex reaching abdominal tergum 5; hamus of hind wing absent; mesosternum lacking an anterior medial carina or tubercle, xyphus broadly swollen; metasternum convex, concave posteriorly to receive dorsal subbasal surface of adpressed third abdominal sternal spine, posterior margin not produced over second abdominal sternum.

Abdomen. Intersegmental suture of abdominal sterna 2-3 terminating dorsolaterally; sternum 2 simple medially; sternum 3 medially with apex of spine reaching to mesosternum.

Legs. fore femora on subapical, anterior margin of inferior surface unarmed; hind femora of male slender when compared to mid and hind femora, subapical inferior surface unarmed.

Female Genitalia. Sclerotised rami present; spermathecal bulb non-spherical in profile, spermathecal duct below proximal flange usually slender, with lateral duct leading to a sac-like expansion (Fig. 5F).

Male Genitalia. Pygophore, external opening posterior in position; aedeagus, vesica forming a mostly sclerotised tube of variable profile; conjunctiva with: one pair of sclerotised dorsomedial processes; one pair of lightly sclerotised dorsolateral proximal processes; one pair of membranous dorsolateral distal processes; remainder as in diagnosis (Fig. 8D).

INCLUDED SPECIES. *Tamolia ramifera* (Walker, 1868), *♀; *Tamolia* undescribed species, ♂♀.

DISTRIBUTION. New Guinea.

BIOLOGY. Food plants and other biological information unknown.

REMARKS. This genus may be confused with *Plisthenes* (Fig. 3C). Only three specimens of this genus are known to the author in collections worldwide.

Tibiospina Sinclair 2000

TYPE SPECIES. *Tibiospina darlingtoni* Sinclair 2000.

DIAGNOSIS. See Sinclair (2000).

DESCRIPTION. See Sinclair (2000).

INCLUDED SPECIES. *Tibiospina darlingtoni* Sinclair, 2000.

DISTRIBUTION. Australia (Wet Tropics area, N Qld).

BIOLOGY. Foodplants and other biological information unknown.

REMARKS. Existing specimens of this genus were collected in higher altitude rainforest.

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NEW SPECIES OF CAVE DWELLING COCKROACHES IN THE GENUS *NEOTEMNOPTERYX* PRINCIS (BLATTARIA: BLATTELLIDAE: BLATTELLINAE)

DAVID P. SLANEY

Slaney, D.P. 2000 12 31: New species of cave dwelling cockroaches in the genus *Neotemnopteryx* Princis (Blattaria: Blattellidae: Blattellinae). *Memoirs of the Queensland Museum.* **46**(1): 331-336. Brisbane. ISSN 0079-8835.

Three new cave dwelling species of the Australian endemic cockroach genus, *Neotemnopteryx* Princis (Blattellidae), are described. All three species, *N. braesensis*, *N. undarensis* and *N. baylissensis* were collected from basaltic larva tube cave systems in northern Queensland. A revised key to the 14 described *Neotemnopteryx* species is included. ❒ *Neotemnopteryx, Blattaria, Blattellidae, Blattellinae, cockroaches, caves, subterranean, Queensland, Australia.*

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Recent studies investigating the origin of Australian tropical cave cockroaches (Slaney, in press) have led to the discovery of three additional species of the cockroach genus *Neotemnopteryx* Princis, 1951 (Blattaria: Blattellidae: Blattellinae) in basaltic larva tube systems to the west of the Wet Tropics region of northern Queensland. One of them completely lacks eyes and ocelli. The genus contains 14 described species including the 3 in this paper, all of which are endemic to Australia (Roth, 1990, 1995). They occupy a variety of habitats including tropical rainforests of northern Queensland, woodlands of coastal Australia, semi-arid shrublands of the interior and caves in Queensland and Western Australia. Of the 14 described *Neotemnopteryx* species, 9 are surface dwelling species and 5 inhabit caves. The previously known cavernicolous species are *N. douglasi* (Princis, 1963), from limestone caves at Jurien Bay, WA, and *N. wynnei* Roth, 1995, from limestone caves on the Nullarbor plain, WA.

In this paper I describe the three new cavernicolous *Neotemnopteryx* species. In addition, a revised key to the 14 described *Neotemnopteryx* species is included. Further information on previously described species of *Neotemnopteryx* can be found in Roth's (1990) revision of this and closely related genera and in Roth (1995).

MATERIALS AND METHODS

Acronyms of repositories are: ANIC, Australian National Insect Collection, CSIRO, Canberra, ACT; MGC, M. Godwin Collection, Department of Environment, Cairns, Queensland; QM, Queensland Museum, Brisbane, Queensland.

The male genitalia dissected from the type material include, if specialised, the seventh abdominal tergum. Genitalia were dissected and prepared from adult specimens by removing the end of the abdomen prior to maceration in 5-10% KOH. They were then cleared in Nesbitts fluid (Upton, 1991), consisting of 40g chloral hydrate in 25mL distilled water to which was added 2.5mL concentrated HCl. Lower concentrations of HCl could be used for slower clearing of delicate specimens. The genitalia were preserved in 80% ethanol and 5% glycerol, and stored in plastic genitalia vials with the type specimens. Genitalia were not slide mounted so as to avoid distortion and obscuring of important structures. In the descriptions I have followed, to a degree, the terminology used by Roth (1990) in his revision of the Australian Parcoblattini. Body dimensions were measured using a stereo-dissecting microscope and ocular micrometer, and are quoted in millimetres. Abbreviations: BL, total body length; PL, pronotum length; PW, pronotum width; EL, eye length; EW, eye width; AL, antenna length; TL, tegmen length; TW, tegmen width.

KEY TO MALES OF *NEOTEMNOPTERYX*

The following key is adapted from Roth's (1990) key and his figures are cited. *Neotemnopteryx fulva* appears in the key twice, since the seventh abdominal tergum may or may not be specialised (Roth, 1990).

1. Seventh abdominal tergum specialised (e.g. Fig.1C) . . 2
   Seventh abdominal tergum unspecialised 8
2. Styles close together at apex of subgenital plate, left style more robust than right (fig. 13E in Roth, 1990) . . . . *N. styliparedra* Roth
   Styles not as above 3
3. Posterior halves of lateral margins of pronotum straight, weakly oblique (figs 6A, 7A in Roth, 1990) 4
   Posterior halves of lateral margins of pronotum not straight 5
4. Supraanal plate subtrapezoidal; right style decidedly more robust than the left (fig. 6B,E in Roth, 1990) . . . . *N. australis* (Saussure)
   Supraanal plate tongue-shaped, with concave sides; right and left styles about the same size (fig. 7B-D in Roth, 1990) . . . . *N. glossa* Roth
5. Hind margin of supraanal plate concavely excavated (fig. 10A in Roth, 1990) . . . . *N. concava* Roth
   Hind margin of supraanal plate not concavely excavated 6
6. Right paraproct with U-shaped sclerotisation (Fig. 1D) 7
   Right paraproct without U-shaped sclerotisation (fig. 5B in Roth, 1990) . . . . *N. gloriousa* Roth
7. Right style more robust than left; median genital phallomere with dark sclerotised claw-shaped apex and preapical projection (Fig. 1E) . . *N. braesensis* sp. nov.
   Right and left styles similar; median genital phallomere without preapical projection (figs 1J, 2E,G in Roth, 1990) . . . . *N. fulva* (Saussure)
8. Hind wings vestigial 9
   Hind wings fully developed 11
9. Eyes present . . . . *N. douglasi* (Princis)
   Eyes absent 10
10. Hind margin of supraanal plate with deep U-shaped indentation (Fig. 2D) . . . . . . *N. baylissensis* sp. nov.
    Hind margin of supraanal plate convexly rounded (fig. 3A in Roth, 1995) . . . . *N. wynnei* Roth
11. Hind margin of supraanal plate with deep U-shaped indentation (Fig. 1F) . . . . *N. undarensis* sp. nov.
    Hind margin of supraanal plate without U-shaped indentation 12
12. Pronotum elliptical, width about 1.5 times length (fig. 11A in Roth, 1990) . . . . *N. elliptica* Roth
    Pronotum not elliptical 13
13. Apex of median genital phallomere bifurcated (figs 8G, 9B in Roth, 1990) . . . . *N. bifurcata* Roth
    Apex of median genital phallomere not bifurcated . . 14
14. Right paraproct with U-shaped sclerotisation (Fig. 1D) . . . . *N. fulva* (Saussure)
    Right paraproct without U-shaped sclerotisation (fig. 12B in Roth, 1990) . . . . *N. nana* Roth

SYSTEMATICS

BLATTARIA
BLATTELLIDAE
BLATTELLINAE
PARCOBLATTINI

Neotemnopteryx Princis 1951

Neotemnopteryx braesensis sp. nov.
(Fig. 1A-E)

ETYMOLOGY. For the type locality, Black Braes lava tubes, about 270km west of Townsville.

MATERIAL. HOLOTYPE. QM T62986, ♂, BB-2 Cave, Black Braes lava tubes, 19°33'S 144°07'E, N Queensland, Australia, 9.v.1997, D.P. Slaney, D. Blair & F. Stone. PARATYPES. Same data as holotype, 2 ♂ (1 with dissected genitalia), 2 ♀, in ANIC, 1 ♂ with dissected genitalia, 2 ♀, in QM; 1 ♂, BB-7 Cave, other data as holotype, in QM. Females with ocelli lacking pigment: 1 ♀, BB-6 Cave, other data as holotype, in QM; 1 ♀, BB-7 Cave, other data as holotype, in ANIC.

DESCRIPTION. MALE. Yellowish brown. Pronotum subparabolic, widest just below middle (Fig. 1A). Eyes reduced, base of eyes reaching just below base of antennal socket. Antennae longer than body. Tegmina fully developed, reaching margin of supraanal plate. Hind wings fully developed, cubitus vein with 3 complete and 2-3 incomplete branches, apical triangle absent. Front femur Type A_3, with anterior ventral margin with 4-5 large spines followed by row of smaller spines terminating in 3 large spines. Tarsal claws symmetrical, unspecialised, pulvilli absent, arolia small. First abdominal tergum with 2 dense fan-shaped groups of setae medially, and a few setae along anterior border partly covered by hind margin of metanotum (Fig. 1B). Seventh abdominal tergum specialised with 2 dense groups of setae medially (Fig. 1C). Hind margin of supraanal plate deflexed (Fig. 1D). Intercercal ridge present, large, lined with numerous small dark spines, extending into genital chamber (Fig. 1D). Paraprocts asymmetrical, right larger, U-shaped with left half covered in short thick dark spines, left paraproct claw-like with few short fine setae (Fig. 1D). Subgenital plate and styles asymmetrical, extending beyond supraanal plate (Fig. 1E). Styles covered with short thick dark brown spines, right style larger, at apex of subgenital plate (Fig. 1E). Left phallomere hook-shaped with subapical incision, overlying large sclerotised plate with numerous small fine spines, median phallomere with dark sclerotised claw-shaped apex and preapical projection, right

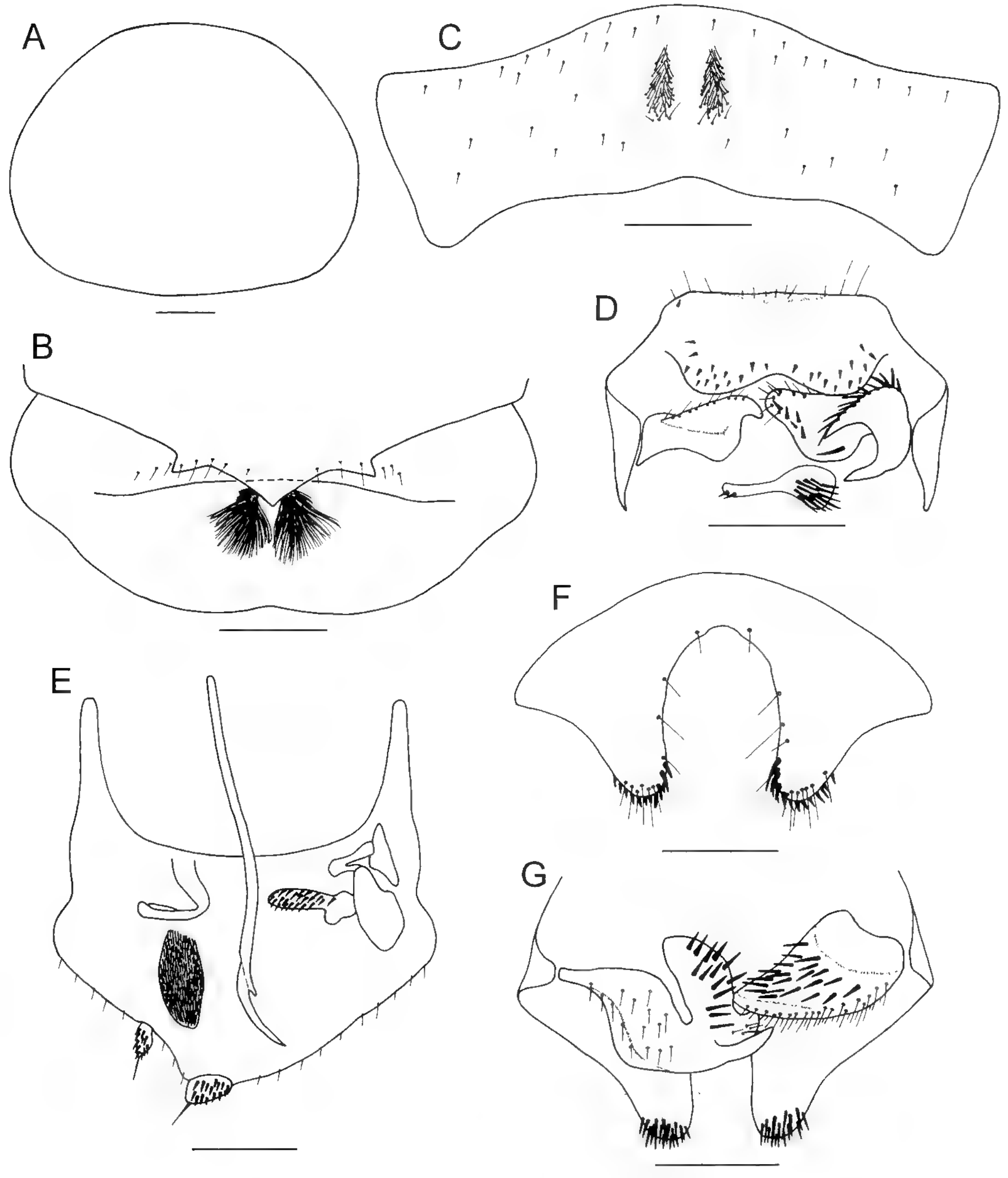

FIG. 1. A-E, *Neotemnopteryx braesensis* sp. nov., ♂. A, pronotum; B, setal gland on first abdominal tergum; C, setal gland on seventh abdominal tergum; D, supraanal plate and paraprocts (ventral view); E, subgenital plate, styles, and phallomeres (dorsal view). F-G, *N. undarensis* sp. nov., ♂. F, supraanal plate (dorsal view); G, supraanal plate and paraprocts (ventral view). Scale bars = 1mm.

phallomere with a cleft and elongated setose plate (Fig. 1E).

Measurements. Holotype first, paratypes in parentheses. BL: 17.2 (14.7-17.3); PL: 4.3 (3.8-4.7); PW: 5.8 (4.6-5.8); EL: 1.5 (1.7-1.9); EW: 0.6 (0.5-0.6); AL: 25.0 (24.5-26.2); TL: 11.6 (10.2-12.5); TW 4.0 (3.6-4.2).

FEMALE. Larger than males. Eyes reduced, base of eyes level with base of antennal sockets.

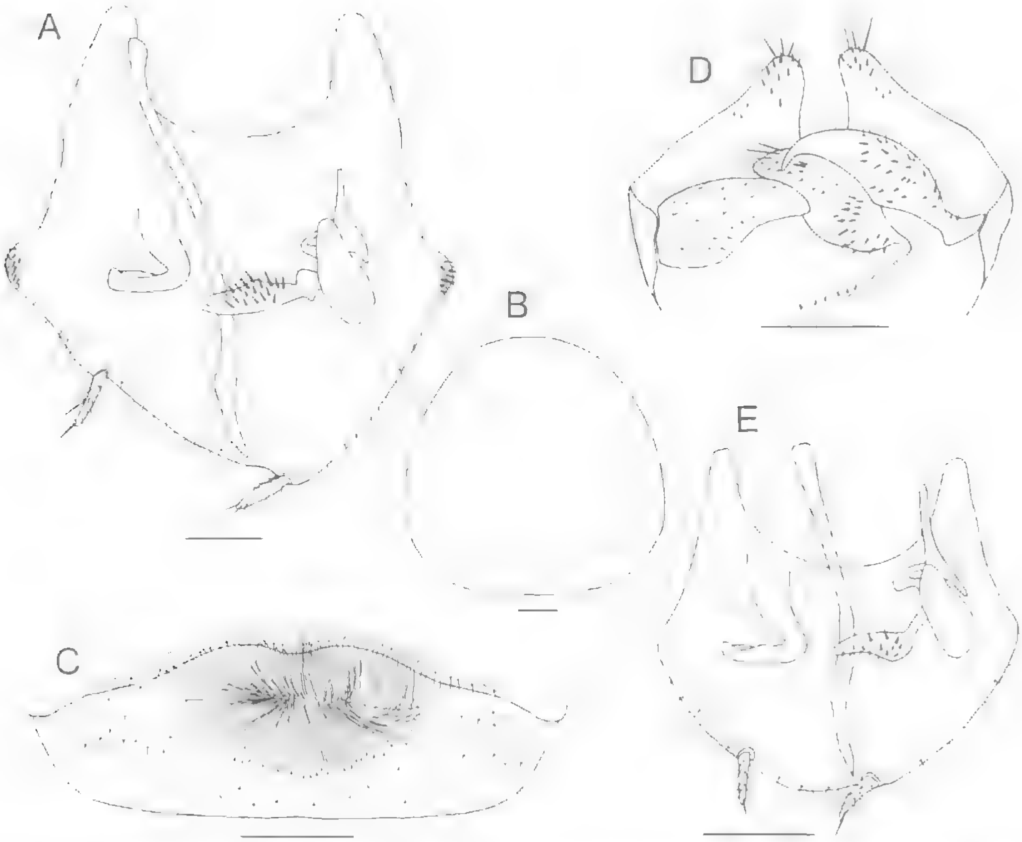

FIG. 2. A, *Neotemnopteryx undarensis* sp. nov., ♂. A, subgenital plate, styles, and phallomeres (dorsal view). B-E, *Neotemnopteryx baylissensis* sp. nov., ♂. B, pronotum; C, setal gland on first abdominal tergum; D, supraanal plate and paraprocts (ventral view); E, subgenital plate, styles, and phallomeres (dorsal view). Scale bars = 1mm.

Supraanal plate triginal. Subgenital plate broad, smoothly rounded. Females with ocelli lacking pigment similar to other females.

Measurements. Females with ocelli lacking pigment in parentheses. BL: 17.5-21.0 (17.2-19.1); PL: 4.2-4.8 (4.4-4.5); PW: 5.6-6.8 (5.5-5.6); EL: 0.9-1.2 (1.1-1.2); EW: 0.4-0.5 (0.5-0.6); TL: 12.9-16.7 (11.9-12.8); TW: 6.4-7.5 (3.6-4.0).

REMARKS. *Neotemnopteryx braesensis* is similar to *Neotemnopteryx fulva* (Saussure) but in *N. braesensis* males the median phallomere has a preapical projection. I consider *N. braesensis* females with unpigmented ocelli to be different morphs of the same species. Although females are larger than males, both female morphs have smaller eyes than males.

Neotemnopteryx undarensis sp. nov.
(Figs 1F,G, 2A)

ETYMOLOGY. For the type locality, Undara lava tubes, about 260km NW of Townsville.

MATERIAL. HOLOTYPE. QM T62987, ♂, Wishing Well Cave (U-52), Undara lava tubes, 18°06'S 144°40'E, N Queensland, Australia, 5.ii.1996, D.P. Slaney & E. Volschenk. PARATYPES. Same data as holotype, 1 ♂ with dissected genitalia, 2 ♀, 2 oöthecae, in ANIC, 1 ♂ with dissected genitalia, 2 ♀, 2 oöthecae,in QM. Same location as holotype, 1 ♀, 2 juv., 14.iv.1990, M. Godwin, MGC3399, 1 ♂, 4 juv., 24.x.1989, A. Little, MGC3635; Hot Hole Cave (U-51), Undara lava tubes,18°07'S 144°40'E,1 ♂, 1 juv., 13.x.1989, M. Godwin, MGC3308; Stevens Cave (U-16), Undara lava tubes, 18°15'S 144°43'E, 4 juv., 14.ix.1994, M. Godwin & G. Barnes, in MGC.

DESCRIPTION. MALE. Yellowish brown. Pronotum subparabolic, widest just below middle (as in Fig. 1A). Base of eyes extending well below base of antennal sockets. Antennae as long as body. Tegmina extending beyond abdomen. Hind wings fully developed, cubitus vein with 5-6 complete and 2-4 incomplete branches, apical triangle absent. Front femur Type A_3, anterior ventral margin with 5-6 large spines followed by row of smaller spines, terminating in 3 large spines. Tarsal claws symmetrical, unspecialised, pulvilli and arolia present. First abdominal tergum with 2 dense groups of fan-shaped setae medially, and numerous setae along anterior border (as in Fig. 1B). Seventh abdominal tergum unspecialised. Supraanal plate with sides concave, hind margin with deep U-shaped excavation, forming pair of apically rounded lobes bearing long slender setae dorsally, densely covered with small dark spines ventrally (Fig. 1F). Intercercal ridge absent. Paraprocts asymmetrical, right with finger-like process, left with numerous short dark setae (Fig. 1G). Subgenital plate and styles asymmetrical (Fig. 2A). Sides of subgenital plate lobed bearing short thick spines (Fig. 2A). Styles similar, elongated, extending beyond margin of supraanal plate, covered with few long and short spines, right style pointing dorsally, left pointing ventrally (Fig. 2A). Left phallomere hook-shaped with subapical incision, median phallomere rod-like with shallow groove in apex, right phallomere with a cleft and elongated setose plate (Fig. 2A).

Measurements. Holotype first, paratypes in parentheses. BL: 26.1 (25.5-26.3); PL: 6.2 (6.0-6.4); PW: 7.7 (7.4-8.0); EL: 2.4 (2.2-2.5); EW: 1.3 (1.2-1.3); TL: 25.5 (23.4-26.0); TW: 7.6 (7.3-7.9).

FEMALE. Larger than males. Supraanal plate similar to male, but extending beyond margin of subgenital plate, with U-shaped excavation not as deep, and lobes lacking dark spines ventrally. Subgenital plate broad, smoothly rounded. Oötheca reddish brown, 7.5-9.8mm long, with 19-28 egg cells.

Measurements. BL: 26.8-27.5; PL: 7.0-7.5; PW: 8.6-9.1; TL: 25.2-27.3; TW: 7.3-8.0; EL: 2.3-2.7; EW: 1.3-1.4.

REMARKS. In males of *N. undarensis* the deep U-shaped excavation in the hind margin of the supraanal plate is similar to that of *Paratemnopteryx broomehillensis* Roth, 1990, and to that of *N. baylissensis* described below. However, in *P. broomehillensis* the seventh abdominal tergum is specialised, and the subgenital plate and styles are symmetrical.

Neotemnopteryx baylissensis sp. nov.
(Fig. 2B-E)

Paratemnopteryx sp.4 Roth, 1990: 583-584.

ETYMOLOGY. For the location of the holotype, Bayliss Cave, which is part of the Undara lava tube system.

MATERIAL. HOLOTYPE. QM T62988, ♂, with dissected genitalia, Bayliss Cave (U-30), Undara lava tubes, 18°15'S 144°35'E, N Queensland, Australia, hand collected at banana bait, 3.ii.1995, D. Blair. PARATYPES. 1 ♀, same locality as holotype, 23.v.1985, F. Howarth, D. Irwin, and F. Stone, 1 ♀, 2 oöthecae, 19.xi.1993, P. Weinstein, in QM; same locality as holotype, 1 ♀, 2 juv., hand collected at sweet potato bait, 23.iii.1997, F. Stone, in ANIC; 1 ♀, Kenny's Cave (U-40), Silent Hill Flow, Undara lava tubes, 18°13'S 144°41'E, 10.iv.1990, M. Godwin, MGC3398, in MGC.

DESCRIPTION. MALE. Pale yellowish brown. Pronotum subparabolic, widest near base (Fig. 2B). Ocelli and eyes absent. Antennae longer than body. Tegmina reduced, reaching T4. Hind wings vestigial, reaching top of T2. Front femur Type A_3, anterior ventral margin with 5 large spines followed by row of smaller spines, terminating in 3 large spines. Tarsal claws symmetrical, unspecialised, pulvilli and arolia absent. First abdominal tergum with large medial depression containing dense group of setae, setae also present surrounding depression (Fig. 2C). Seventh abdominal tergum unspecialised. Supraanal plate with sides concave, hind margin with deep U-shaped excavation, forming pair of apically rounded lobes bearing small dark spines ventrally, and long thin spines at apex and dorsally (as in Fig. 1F). Intercercal ridge absent. Paraprocts asymmetrical, right with finger-like process, with few short dark spines, left paraproct claw-like (Fig. 2D). Subgenital plate and styles asymmetrical, extending beyond margin of supraanal plate (Fig. 2E). Styles similar, elongated, covered with few long and short spines (Fig. 2E). Left phallomere hook-shaped with subapical incision, median phallomere rod-like, apically acute, right phallomere with plate with short spines (Fig. 2E).

Measurements. Holotype, BL: 22.6; PL: 6.3; PW: 6.3; TL: 9.0; TW: 4.3.

FEMALE. Larger than males. Ocelli and eyes absent. Supraanal plate trigonal, lateral margins concave, apex shallowly indented. Subgenital plate broad, rounded, forming peak at apex.

Oötheca pale yellowish brown, 6.4-6.5mm long, with 9-10 egg cells.

Measurements. TL: 22.2-26.6; PL: 6.5-6.7; PW: 6.6-7.3; TL: 8.3-8.6; TW: 4.2-4.7.

REMARKS. Individuals of *N. baylissensis* lack ocelli and eyes. While collecting specimens of *N. baylissensis*, cockroaches were noted not to respond to the light from headlamps. Roth (1990) recorded a female individual of this species collected from Bayliss cave as a species of *Paratemnopteryx* (*P.* sp. 4), although he remarked that the habitus of the female resembled that of *Neotemnopteryx douglasi* (Princis). The U-shaped excavation in the hind margin of the supraanal plate of the male *N. baylissensis* specimen is similar to that of *N. undarensis* and *P. broomehillensis*, however, the asymmetrical subgenital plate and the habitus of the recently collected male specimen leads me to conclude that the specimens are a new species of *Neotemnopteryx*. In addition, aligned molecular sequence data obtained from the entire mitochondrial cytochrome oxidase II gene (COII) further support the inclusion of *N. baylissensis* in the genus *Neotemnopteryx* (Slaney, unpubl. data).

ACKNOWLEDGEMENTS

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TAXONOMY OF THE AUSTRALIAN RAINFOREST SNAIL, *HELIX BELLENDENKERENSIS* BRAZIER, 1875 (MOLLUSCA: EUPULMONATA: CAMAENIDAE)

JOHN STANISIC

Stanisic, J. 2000 12 31: Taxonomy of the Australian rainforest snail, *Helix bellendenkerensis* Brazier, 1875 (Mollusca: Eupulmonata: Camaenidae). *Memoirs of the Queensland Museum* 46(1): 337-348. Brisbane. ISSN 0079-8835.

The taxonomy of *Helix bellendenkerensis* Brazier, 1875 from the Wet Tropics Biogeographic Region, northeastern Queensland is reviewed. Reproductive anatomy and shell micro-sculpture were examined and indicate that this species is not closely related to other species grouped in *Hadra* Albers, 1860 (type: *Helix bipartita* Ferussac, 1822) by Smith (1992). Consequently *Gnarosophia* Iredale, 1933 with *H. bellendenkerensis* as type, is removed from the synonymy of *Hadra* and re-established as a monotypic genus. *Helix beddomae* Brazier, 1878, *Thersites castanea* Odhner, 1917, *Gnarosophia humoricola* Iredale, 1937 and *Thersites pterinus* Clench and Archer, 1938 are considered to be synonyms of *H. bellendenkerensis*. Details of the habitat and distribution of *H. bellendenkerensis* are provided and it is concluded that this species was most likely an early coloniser of the base-of-the-cape rainforests. Records indicate that it is altitudinally restricted to rainforest above 400m where microclimates are wetter than in the lowlands. Its present distribution within the Wet Tropics is considered to be the result of fragmentation and contraction of rainforest resulting from mid- to late Tertiary climatic changes. ☐ *Australia, rainforest, taxonomy, Mollusca, Camaenidae, Gnarosophia*

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received 23 October 2000.

One of the most speciose groups of land snails in Australia is the Camaenidae. It is common in many parts of the continent but has radiated prolifically in the rainforests of eastern Australia (Solem, 1992, 1998). Representatives of the family occur from the islands of the Torres Strait to Victoria but diversity attenuates from north to south with relatively few occurring south of the Sydney Basin, central New South Wales. Its origins are considered to be in the land masses north of Australia with initial immigration occurring after the collision of the Asian and Australian plates (McMichael & Iredale, 1959; Bishop, 1981; Smith & Stanisic, 1998; Solem, 1992, 1998).

Shell form among the eastern Australian camaenids is diverse and a number of subgroupings (including both genera and nominal families) have been proposed on the basis of gross similarity in shell characters (Iredale, 1933, 1937, 1938). Among these is a group of mainly Queensland camaenids that inhabit rainforest and whose members are characterised by large and often banded shells. These species have been loosely referred to as the 'hadroid' camaenids, a term stemming from their placement in the section *Hadra* of the conglomerate genus *Helix* by Pilsbry (1890). They have been the focus of shell collectors over many years but their current classification is severely flawed and in need of review.

One of the major stumbling blocks to such a revision is the confusion surrounding existing names. Many taxa (species and genera) have been established based on broad shell characters (size, shape and colour) (Iredale, 1933, 1937, 1938). Investigations have shown that these shell characters may be influenced by local factors (environmental selection) and can be highly convergent in distantly related species. This has also been demonstrated in Western Australian Camaenidae by Solem (1985). Many of the Iredalean taxa been criticised for their poor scientific basis (Solem, 1959; Zilch, 1959; Burch, 1976) and need to be reassessed. But Iredale (1937) did stress that his arrangement was 'purely tentative' and intended merely to create minimal order from the existing chaos.

Few details are available on the anatomy of the hadroids. Hedley (1890), Pilsbry (1894), Bishop (1978a, b), Solem (1979, 1992) and Stanisic (1996a, b) represent the bare handful of articles that have attempted to provide some information on the reproductive anatomy of the hadroids. These studies, particularly the pioneering work of Pilsbry (1894), indicate that a comprehensive study of their genitalia would lead to a more stable arrangement of taxa than is currently the case.

The proliferation of species-level taxa among the hadroid camaenids in the past has also been exacerbated by brief descriptions, lack of accompanying illustrations and limited access to existing type material. Hence most type material of these species needs re-examination prior to dealing with the many undescribed hadroid species now known from Queensland (Stanisic, unpubl.). Typical of this confusion is the case recently outlined by Stanisic (1998) for *Temporena whartoni* (Cox, 1871) from the Bowen area, northeastern Queensland.

At least 45 camaenids occur in the Wet Tropics Biogeographic Region of northeastern Queensland, many undescribed (Stanisic et al., 1994). These include a number of hadroids with diverse shell form that inhabit rainforest habitats ranging from humid lowland rainforest to dry vine thickets. This study examines key aspects of the morphology of *Helix bellendenkerensis* Brazier, 1875, a species occurring mainly in the upland and highland rainforests of the Wet Tropics. It is currently associated with the large camaenids belonging to *Hadra* Albers, 1860 (Smith, 1992). Herein, the reproductive anatomy and shell microsculpture of *Helix bellendenkerensis* are analysed and compared with patterns found in *Hadra* spp.

All material used in this study is in the Queensland Museum, Brisbane (QMMO) and the Australian Museum, Sydney (AMSC), Australia. One listed specimen is from the Naturhistoriske Riksmuseum, Stockholm, Sweden (NHRM1545). This specimen was not sighted and the citation is based on Smith (1992).

Abbreviations used in the specimen list are as follows. Collectors: DC, D.J. Cook; DP, D. Potter; DY, D.K. Yeates; GM, G.B. Monteith; GT, G. Thompson; HJ, H.A. Janetzki; HD, H. Dick; IF, I. Fanning; IL, I. Loch; JC, J. Covacevich; JS, J. Stanisic; KM, K. McDonald; LR, L. Roberts; MB, M.J. Bishop; RL, R. Leggett; RS, R. Sheridan; SJ, S.W. Jackson; SW, S. Wilson. Others: Exped, Expedition; EW, Earthwatch; L, Lake; NP, National Park; NVF, notophyll vine forest; SF, State Forest; SMVFT, simple microphyll vine-fern thicket; Tbld, Tableland; Ra, Range; R, River.

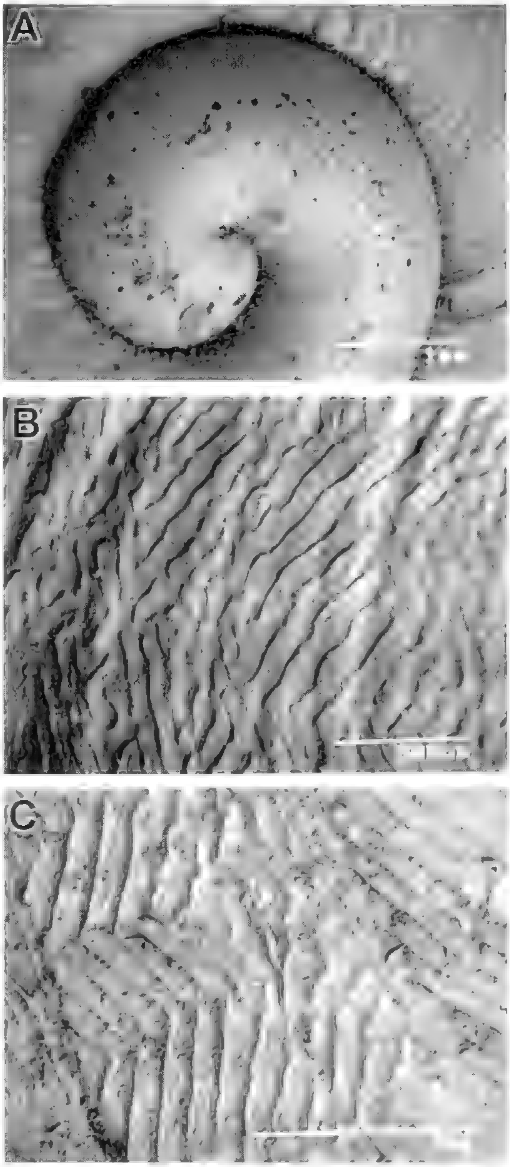

FIG. 1. *Gnarosophia bellendenkerensis*, QM MO48283. A, protoconch; B, sculpture on early adult whorls; C, sculpture on body whorl. Scale lines as marked.

PREVIOUS STUDIES

Pilsbry (1890) first placed *Helix bellendenkerensis* Brazier, 1875 in the sub-grouping *Hadra* Albers, 1860 (type *Hadra bipartita* Ferussac,

1822) within *Helix*. Subsequently Pilsbry (1894) made *Hadra* a section of the subgenus *Thersites* Pfeiffer, 1855 (type: *Helix richmondiana* Reeve, 1852 and moved *H. bellendenkerensis* to the section *Sphaerospira* Mörch, 1867 (type: *Helix fraseri* Griffith & Pidgeon, 1833) within *Thersites*. Most of the eastern Queensland camaenids with large and striped shells were included here. Pilsbry's studies were based on both shell characters and reproductive anatomy, and while incomplete, were beginning to resolve a very confused situation. However, as Fulton (1904) pointed out, the lack of 'authentic' material made his task difficult. Fulton (1904), armed with types, co-types and the knowledge gained from studying a number of local collections, including that of Dr J.C. Cox (author of the first monograph of Australian land shells and many of the early hadroid species), revised Pilsbry's section *Sphaerospira*. Consequently several species were excluded, including *Helix bellendenkerensis* which was tentatively placed in *Hadra*. Iredale (1933) considered this species to differ significantly from *Hadra* because of its 'strong wrinkled sculpture' and introduced *Gnarosophia* to accommodate it (as type), and a number of other northeastern Queensland camaenids. This classification was maintained by Iredale (1937) in his list of the Australian land Mollusca. Smith (1992) synonymised *Gnarosophia* and the far north Queensland *Micardista* Iredale 1933 (type: *Helix (Camaena) barneyi* Cox, 1873) with *Hadra*. Smith (1992) incorporated nine species in *Hadra*: *H. bipartita*, *H. barneyi*, *H. webbi* (Pilsbry,1900), *H. bartschi* (Marshall, 1927), *H. funiculata* (Reeve, 1854), *H. semicastanea* (Pfeiffer, 1859), *H. wilsoni* (Solem, 1979), *H. beddomae* (Brazier, 1878) and *H. bellendenkerensis*.

THIS STUDY

Scanning electron microscopy revealed that the wrinkled periostracal sculpture of *Helix bellendenkerensis* consists of radially disposed ridges occasionally arranged in a chevron-like pattern (Fig. 1B,C) that extend from the first post-embryonic whorls to the body whorl. These are also present in *H. beddomae* but are absent in *H. bipartita*, *H. barney*, *H. webbi*, *H. funiculata*, *H. semicastanea* and *H. bartschi* in which the early adult whorls display a pattern of crowded to scattered pustules that on later whorls give rise to a series of pustules and ridgelets arranged in vaguely spiral rows. This basic structural difference in microsculpture suggests that *H. bellendenkerensis* and *H. beddomae* are not closely related to the main mass of *Hadra* spp. *H. wilsoni* was not examined.

The reproductive anatomy of *H. bipartita* was detailed by Solem (1979) and showed several important features which this species has in common with *H. webbi*, *H. barneyi*, *Jacksonena rudis* (Hedley, 1912) and species grouped in *Spurlingia* Iredale, 1933 by Smith (1992) (Stanisic, unpubl.). The penis in these species is short, tubular and lacks a verge. The penial chamber has a series of longitudinal thickenings that may be supplemented by a short pustular zone apically. An apical collar separates the penis from the epiphallus. Epiphallic caeca (one on the epiphallus and one at the epiphallus-vas deferens junction) are also present. *S. forsteriana* (formerly placed in *Zyghelix* Iredale, 1933) shows some deviation from this general pattern in having the male genitalia very elongated, but otherwise has the characters that align it with the *Hadra-Spurlingia-Jacksonena* lineage. Detailed data on these species will be presented elsewhere but the important point is that they form a strongly cohesive unit based on their reproductive anatomy. Significantly though, this anatomical cohesion belies gross differences in shell morphology of genera within this lineage. In contrast the reproductive structures of *Helix bellendenkerensis* show several significant departures from these species. The penis is very elongate with a sculptured cylindrical verge through which the epiphallus opens (Fig. 2B). The upper third of the penial chamber has crowded, sub-rectangular pustules while thick fleshy longitudinal ridges are present in the lower two thirds. There is no apical penial collar; a knob-like epiphallic caecum is present at about halfway along its length; and a long, tapering, muscular flagellum emanates from the epiphallus-vas deferens junction (Fig. 2A). These differences separate *H. bellendenkerensis* from the *Hadra-Spurlingia-Jacksonena* lineage and indicate that this species deserves separate generic status. Although *H. beddomae* was not dissected, the shell microsculpture aligns this species with *Helix bellendenkerensis*. It is herein considered a synonym of that species pending the examination of the reproductive anatomy. A revised taxonomy including a redescription of *Helix bellendenkerensis* is presented below.

Order EUPULMONATA
Superfamily CAMAENOIDEA
Family CAMAENIDAE

Gnarosophia Iredale, 1933

Gnarosophia Iredale, 1933: 46; Iredale, 1937: 25; Burch, 1976: 135; Smith, 1992: 129 (in synonymy).

TYPE SPECIES. *Helix bellendenkerensis* Brazier, 1875-by original designation.

DIAGNOSIS. Shell large to very large with microsculpture of crowded, radially disposed microridgelets occasionally arranged in a chevron-like pattern. Protoconch and first teleoconch whorl with vague radial growth lines, tending to be smooth. Penial chamber with crowded sub-rectangular to rhomboidal pustules apically; longitudinal ridges basally. Epiphallus relatively short (less than half length of penis), opening into penis through prominent sculptured, cylindrical verge; knob-like epiphallic caecum about halfway along length of epiphallus and a long, tapering epiphallic flagellum present at the epiphallus-vas deferens junction.

REMARKS. *Gnarosophia* is herein considered to be a monotypic genus. The status of other species placed in *Gnarosophia* by Iredale (1937) is not reviewed here. These species have a superficially similar periostracal microsculpture to *Gnarosophia bellendenkerensis* but differ significantly from this species in reproductive anatomy (Stanisic, unpubl.). Closer examination of the periostracal microsculpture of these species also reveals important differences in the structure and disposition of the micro-ridges compared with *G. bellendenkerensis*. They appear to form a monophyletic assemblage but are not considered to be closely related to *H. bellendenkerensis*.

Gnarosophia bellendenkerensis Brazier, 1875
(Figs 1-4)

Helix bellendenkerensis Brazier, 1875: 32.
Helix beddomae Brazier, 1878: 80.
Helix (Hadra) bellendenkerensis: Pilsbry, 1890: 161.
Helix (Hadra) beddomae: Pilsbry, 1890: 174.
Thersites (Sphaerospira) bellendenkerensis: Pilsbry, 1894: 134; Cox, 1909: 11.
Thersites (Sphaerospira) beddomae: Pilsbry, 1894: 134; Cox, 1909: 10.
Hadra bellendenkerensis: Fulton, 1904: 10; Smith, 1992
Hadra beddomae: Fulton, 1904: 10; Smith, 1992: 130.
Thersites castanea Odhner, 1917: 87; 123; Smith, 1992: 130 (in synonymy).
Gnarosophia castanea: Iredale, 1937: 26.
Gnarosophia beddomae: Iredale, 1937: 25.
Gnarosophia bellendenkerensis: Iredale 1933: 46; Iredale, 1937: 25.
Gnarosophia humoricola Iredale 1937; Smith, 1992: 130 (in synonymy).
Thersites pterinus Clench & Archer, 1938: 21; Iredale, 1938:123; Smith, 1992: 130 (in synonymy).

COMPARATIVE REMARKS. *Gnarosophia bellendenkerensis* can be distinguished from other large camaenids in the Wet Tropics on the basis of microsculpture, and with rare exception, shell colour. The chevron-like pattern of periostracal wrinkles of *G. bellendenkerensis* is not seen in other Wet Tropics hadroids. *Monteithosites helicostracum* Stanisic, 1996 from Bakers Blue Mt and Hanns Tbld. has spiral wrinkles and *Hadra bipartita* and *H. webbi* have pustules apically and ridgelets toward the aperture. Other Wet Tropics hadroids grouped in *Gnarosophia* by Iredale (1937): *palmensis* Brazier, 1876; *mazee* Brazier, 1878; *bellaria* Iredale, 1937; *rawnsleyi* Cox, 1873; *mourilyani* Brazier, 1875 have pustules on the early spire giving way to radially disposed wrinkles and ridgelets on the latter whorls. These five species have multi-banded shells as does *M. helicostracum*. In contrast, the shell of *G. bellendenkerensis* is brown to black all-over with two light coloured bands only: one subsuturally and one at the periphery. *Hadra bipartita* and *H. webbi* have bi-coloured shells with the apex and spire generally yellow and the base brown to black (rarely yellow all-over). This bipartite colour form is found only in *G. bellendenkerensis* occurring in the Cardwell Ra. No *Hadra* s.s. species are known to occur at this locality.

TYPE MATERIAL. NEQ: HOLOTYPE: AMSC17631, Mt Bellenden Ker, c. 40km S of Cairns, Dalrymple NE Coast Exploring Exped., W. Hill, R. Johnstone, ex. J.Brazier coll (Height of shell = 40.46mm, diameter = 45.46mm, H/D = 0.89, whorls = 6 1/4). OTHER TYPE MATERIAL. AMSC17632, Cardwell Ra., c. 32km NW Cardwell, 1070m, C.E. Beddome, c.1871 (holotype of *Helix beddomae*) (Height of shell = 37.89mm, diameter = 47.19mm, H/D = 0.80, whorls = 6 1/8); AMSC41901, NHRM1545, Cedar Creek, Atherton Tbld., Dr. E.J. Mjoberg, ex. N. Odhner (2 syntypes of *Thersites castanea*) (Height of shell of AMS specimen = 32.07mm, diameter = 38.33mm, H/D = 0.84, whorls = 6 1/8); QMMO1769, L. Barrine, Atherton Tbld., Harvard-Australian Exped., 1932 (holotype of *Thersites pterinus*) (Height of shell = 28.92mm, diameter = 39.08mm, H/D = 0.74, whorls = 5 3/4); AMSC100630, Innisfail, under logs in dense scrub, SJ, 1908 (holotype of *Gnarosophia humoricola*). (Height of shell = 42.86mm, diameter = 52.23mm, H/D = 0.81, whorls = 6 1/8); AMSC106798, 3 adults same data as previous, (paratypes of *G. humoricola*).

OTHER MATERIAL. NEQ: QMMO48769, 1, 12 Mile Scrub, Helenvale (15°46'S, 145°15'E), 300m, Rf., under

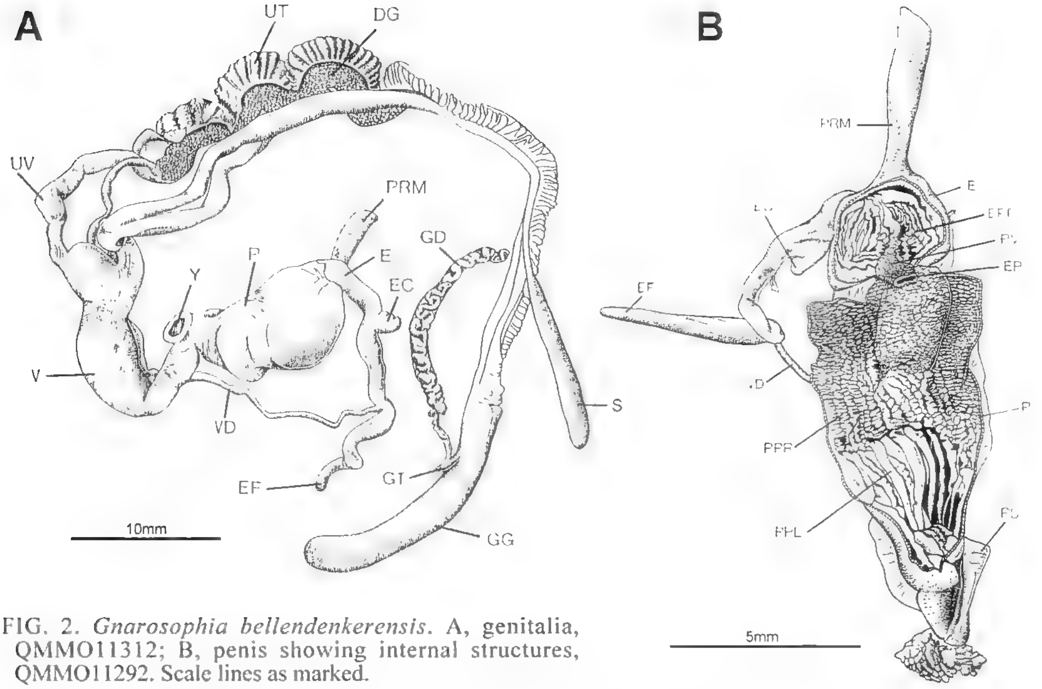

FIG. 2. *Gnarosophia bellendenkerensis*. A, genitalia, QMMO11312; B, penis showing internal structures, QMMO11292. Scale lines as marked.

log, P. Filewood; QMMO56777, 1, summit Mt Hartley S of Helenvale (15°46'S, 145°20'E), 790m, Rf., GM, 8.xi.1995; QMMO48733, 1, summit Mt Finnigan S of Helenvale (15°48'S, 145°17'E), 1050m, Rf., GM, RS, LR, GT, 3.xii.1990; QMMO48555, 1, Mt Sampson S of Helenvale (15°48'S, 145°12'E), 600-790m, Rf., ANZSES Exped., 26.xii.1990; QMMO16426, 2, summit Mt Finnigan S of Helenvale (15°49'S, 145°16'E), 1100m, GM, 29.xi.1985; QMMO48595, 1, Mt Misery S of Helenvale (15°53'S, 145°13'E), 500-850m, Rf., ANZSES Exped., 2.i.1991; QMMO56180, 5, c. 30km SSW Helenvale at Mt Boolbun (15°56'S, 145°08'E), 850m, simple NVF, HJ, GM, JC, 5.xi.1995 ; CAPE TRIBULATION: QMMO60878, 1, Mt Donovan (16°01'S, 145°25'E), 600m, HD; QMMO48602, 1, Mt Halcyon (16°03'S, 145°25'E), 870m, Rf.,GM, HJ, DC, LR, 22.xi.1993; QMMO48683, 2, Mt Halcyon (16°03'S, 145°25'E), 850m, Rf.,GM, HJ, DC, LR, 22.xi.1993; QMMO48549, 5, 4.5-5.0km W, (16°04'S, 145°25'E), 760-780m, Rf., GM, DY, 21.iv.1983; QMMO47698, 2, Pilgrim Sands (16°04'S, 145°28'E), 20m, Qld Naturalists; QMMO48657, 6, Roaring Meg Valley (16°04'S, 145°25'E), 720m, Rf., GM, HJ, DC, LR, 21.xi.1993; QMMO48578, 1, Mt Pieter Botte (16°05'S, 145°24'E), 950m, Rf., GM, HJ, DC, LR, 21.xi.1993; QMMO60879, 1, Mt Pieter Botte (16°05'S, 145°24'E), 950m, HD; QMMO48764, 1, Mt Sorrow (16°05'S, 145°26'E), 800m, Rf., GM, 19.x.1980; QMMO48633, 2, Mt Hemmant, 6km SW (16°07'S, 145°25'E), 1050m, Rf., GM, HJ, DC, LR, 25.xi.1993; QMMO48696, 1, Mt Hemmant, 6km SW (16°07'S, 145°25'E), 1050m, Rf.,DC, HJ, LR, 25.xi.1993. THORNTON PEAK: QMMO15049, 1 (16°09'S, 145°21'E), 600m, JC, SW, 22.ix.1984; QMMO48704, 2 (16°10'S, 145°22'E),1100-1300m, Rf., GM, 24.ix.1984; QMMO48712, 3, (16°10'S, 145°22'E), 1000-1300m, Rf.,GM, DC, 20.ix.1981; QMMO48723, 2, (16°10'S, 145°22'E), 1100-1200m, Rf.,GM, DY, GT, 30 Oct1983; QMMO48655, 2, Hilda Creek (16°10'S, 145°22'E), 800-900m, Rf.,GM, RL, 25.ix.1984. QMMO59136, 1, Blue Hole, c.10km NE Daintree (16°11'S, 145°24'E),140m, Rf., under log, JS, 25.ix.1996; QMMO60880, 1, Windsor Tbld. (16°15'S, 145°02'E), 1200m, HD; QMMO48517, 2, Windsor Tbld., 35km NNW Mt Carbine, (16°15'S, 145°02'E), 1150m, Rf.,GM, DY, DC, 25.iv.1982 ;QMMO10011, 1, Windsor Tbld. (16°17'S, 145°04'E), 850m, edge of Rf., IF, 30.xii.1980; QMMO10012, 1, Windsor Tbld. (16°17'S, 145°04'E), 850m, edge of Rf., IF, 29.xii.1980; QMMO48508, 1, Windsor Tbld., 28km NNW Mt Carbine (16°17'S, 145°04'E), 900m, Rf.,GM, DY, DC, 15.iv.1982; QMMO48744, 3, 7km N Mt Spurgeon (16°22'S, 145°13'E), 1250m, Rf, GM, HJ, DC, LR, 17.x.1991; QMMO48330, 2, Black Mt, c.4.5km N Mt Spurgeon (16°24'S, 145°12'E), 1250-1330m, Rf,GM, HJ, DC, LR, 17.x.1991; QMMO48270, 1, Mossman, 10km NW, Devils Thumb (16°24'S, 145°17'E), 1200m, Rf., GM& RS, 27.xi.1990; QMMO48266, 3, Mossman, 11km NW (16°24'S, 145°16'E), 1330m, Rf., GM, GT, DC, RS, HJ, 27.xi.1990; QMMO48350, 5, Stewart Ck, c.4km NNE Mt

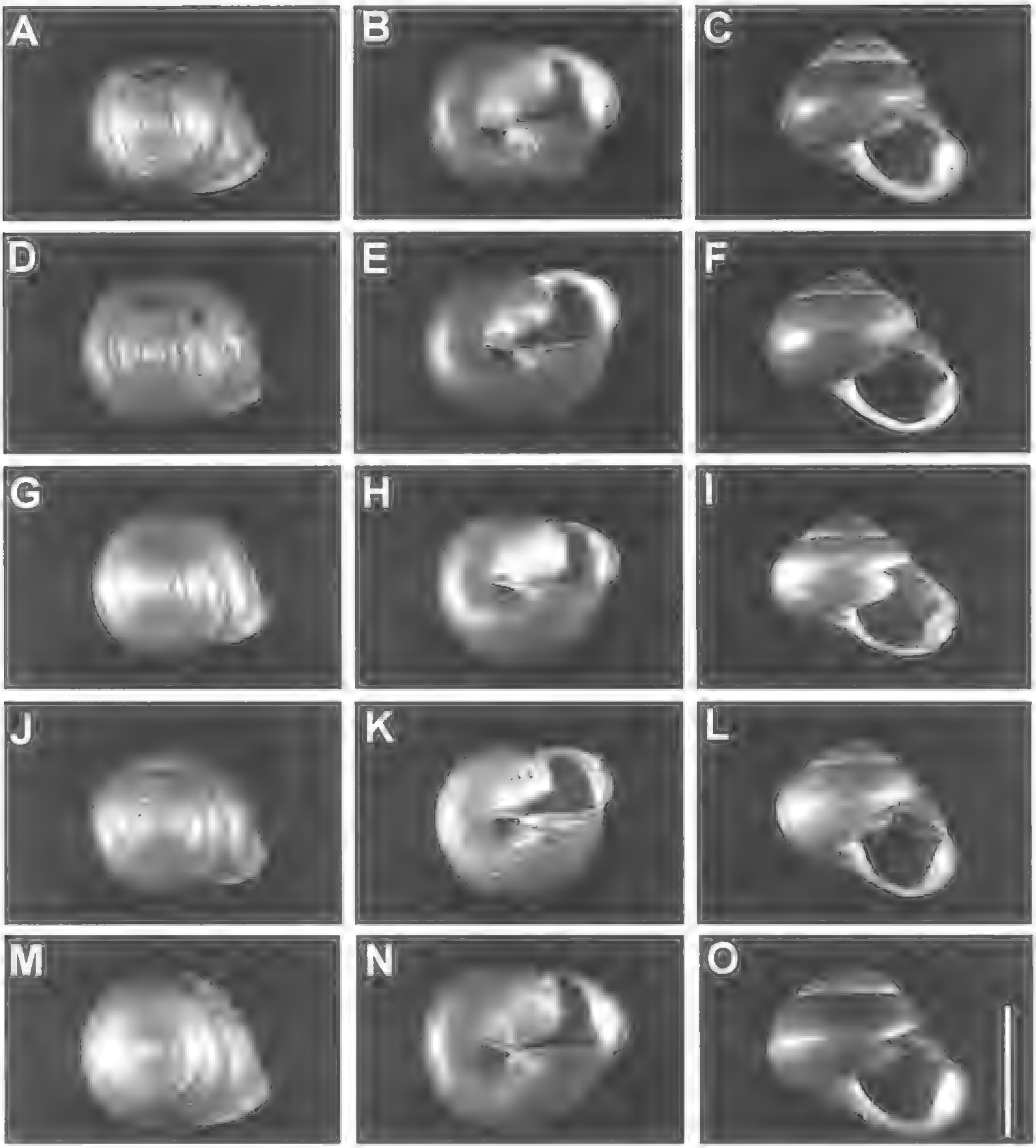

FIG. 3. A-C, AMSC17631, holotype of *Helix bellendenkerensis*; D-F, AMSC17632, holotype of *Helix beddomae*; G-I, QMMO1769, holotype of *Thersites pterinus*; J-L, AMSC41901, syntype of *Thersites castanea*; M-O, AMSC100630, holotype of *Gnarosophia humoricola*. Scale line = 50mm.

Spurgeon (16°24'S, 145°13'E), 1250-1300m, Rf., GM, GT, HJ, DC, LR, 15.x.1991; QMMO48258, 2, Mossman, 12km NW, Roots Ck (16°25'S, 145°16'E), 1200m, Rf., ANZSES Exped., 28.xii.1990; QMMO48283, 2, ANZSES Exped., 1.i.1990, QMMO48287, 1, GM, GT, DC, RS, HJ, 28 Nov 1990, Mossman, 13km W, Pauls Luck (16°26'S, 145°15'E), 1100m, Rf.; QMMO48339, 2, Mt Spurgeon, c.2km SE, (16°27'S, 145°12'E), 1100m, Rf.,GM, HJ, DC, 13.xi.1991; QMMO48299, 4, QMMO48307, 2, GM, GT, 17.xii.1988, QMMO48321, 4, GM, GT, ANZSES, 20.xii.1989, Mossman 9km W, Mossman Bluff Track (16°28'S, 145°17'E), 1000m, Rf.; QMMO31064, 1, Mossman, c.4.4km W, Mossman Gorge (16°29'S, 145°20'E), 200m, Rf., crawling on rock, JS, DP, 29.vi.1983; QMMO48246, 1, Mossman, 7km SE, Mt Demi (16°30'S, 145°19'E), 1100m, Rf., DY, GT, 29.x.1983; QMMO16258, 1, JS, 1.x.1980, QMMO48239, 1, ANZSES Exped., 13.i.1990, Mt Lewis Rd, Old Barracks area (16°35'S, 145°16'E), 100m, Rf.; QMMO60242, 2, Mt Lewis, c.6km WNW Julatten (16°35'S, 145°17'E), Rf., under logs, R. Crookshanks, 2.iii.1997; QMMO31054, 2, under logs and rocks, 27.vi.1983, QMMO24605, 2, under logs, 8.x.1988, Mt Lewis (16°36'S, 145°16'E), 1000m, JS, DP; QMMO48209, 3, Julatten, 17km ESE, Black Mt (16°39'S, 145°29'E), 1000m, Rf.,GM, DC, DY, 14.iv.1982; QMMO48623, 2, Lamb Ra., Mt Williams (16°55'S, 145°40'E), 1000m, Rf., GM, HJ, DC, 2.xii.1993; QMMO48190, 1, Lamb Ra., Chujeba Peak summit (16°56'S, 145°39'E), 1000m, Rf., GM, GT, 14.xii.1989; QMMO48439, 1, Lamb Ra., 20km SE Mareeba, Davies Ck Rd (17°02'S, 145°35'E), 750m, Rf.,GM, GT, 17.xii.1989; QMMO48193, 4, GM, GT, QMMO48206, 1, GM, GT, HJ, Lambs Head, 10km W Edmonton (17°02'S, 145°38'E), 1200m, Rf.; QMMO24797, 2, Lamb Ra., c.17.5km along Davies Ck Rd from Cairns-Mareeba Rd (17°03'S, 145°37'E), 1000m, Rf., under log, JS, DP, 11.x.1988; QMMO48582, 4, QMMO48663, 1, Lambs Head, E, Isley Hills (17°03'S, 145°42'E), 1050m, Rf.,GM, HJ, DC, 30.xi.1993; QMMO48692, 1, Lambs Head, NW, upper Isley Ck (17°03'S, 145°41'E), 750m, Rf., GM, HJ, DC, 29.xi.1993; QMMO48139, 1, Malbon Thompson Ra., North Bell Peak (17°05'S, 145°53'E), 900-1000m, Rf., GM, DC, 15.ix.1981; QMMO48156, 2, Lamb Ra., Mt Edith (17°06'S, 145°37'E), 1000m, Rf., GM, DY, GT, 12.x.1982; QMMO25925, 1, Lamb Ra., c.1.9km N Tinaroo SF Rd, Tinaroo Dam- Mt Edith Rd (17°07'S, 145°37'E), 700m, Rf., under log, JS, DP, 12.x.1988; QMMO25927, 1, Lamb Ra., c.0.9km N Tinaroo SF Rd, Tinaroo Dam- Mt Edith Rd (17°08'S, 145°37'E), 700m, Rf., under log, JS, DP, 12)ct 1988; QMMO60241, 2, Cairns, S, lower Mulgrave R. (17°11'S, 145°54'E), Rf., under logs, R. Crookshanks, 25.ii.1997; QMMO6903, 1, Atherton Tbld., L. Barrine (17°15'S, 145°36'E), 800m, MB; QMMO1769, 1, Atherton Tbld., L. Barrine (17°15'S, 145°38'E), Harvard Exped., 1931-32. MT BELLENDEN KER: QMMO48765, 1, 25.x.1981, QMMO11252, 1, 17.x.1981, summit Centre Peak (17°15'S, 145°51'E), 1560m, SMVFT, EW/QM; QMMO11312, 4, 25.x.1981, QMMO11328, 1, 1.xi.1981, 1km S cable tower 6 (17°16'S, 145°53'E), 500m, Rf., EW/QM; QMMO11361, 3, c.1km N (17°16'S, 145°53'E), 100m, Rf., EW/QM, 1.xi.1981; QMMO11329, 6, 1.xi.1981, QMMO48565, 3, Rf., 25.x.1981, cable tower 3 (17°16'S, 145°52'E), 1054m, EW/QM; QMMO11276, 4, EW/QM, 17.xi.1981, QMMO11292, 6, EW/QM, 25.x.1981, QMMO31235, 1, under log, 3.vii.1983, JS, DP, cableway base (17°16'S, 145°53'E), 100m, rainforest; QMMO31245, 1, just below summit (17°16'S, 145°51'E), 1500m, under logs, JS, DP, 4.vii.1983; QMMO48061, 2, c.4km W centre peak (17°16'S, 145°49, 'E) 1250m, Rf., GM, HJ, DC, 9.x.1991. QMMO50347, 2, Atherton Tbld., 2km W Yungaburra, Thomas Rd (17°16'S, 145°34'E), Rf., on forest floor and tree bases, 11.v.1996; QMMO6910, 7, Atherton Tbld., L. Eacham (17°17'S, 145°36'E), 800m, MB; QMMO16299, 1, Atherton Tbld., L. Eacham (17°17'S, 145°37'E), 800m, Rf., under log, H. Vokes, 29.ix.1980; QMMO48766, 1,GM, 8.x.1980, QMMO51732, 1, L. Winsor, 15.ix.1977, Atherton Tbld., Malanda Falls (17°21'S, 145°35'E), 750m, Rf., MT BARTLE FRERE: QMMO11415, 1, summit NW peak (17°23'S, 145°48'E), 1440m, SMVFT, EW/QM, 8.xi.1981; QMMO48079, 1, NW to Centre peak (17°23'S, 145°48'E), 1500m, Rf.,EW/QM, 7.xi.1981; QMMO11401, 2, summit Centre peak (17°23'S, 145°48'E), 1540m, SMVFT, EW/QM, 7.xi.1981; QMMO11373, 3, walking track below NW peak (17°23'S, 145°48'E),1540m, SMVFT, EW/QM, 8.xi.1981; QMMO11391, 3, summit S peak (17°24'S, 145°49'E), 1620m, SMVFT, EW/QM, 7.xi.1981; QMMO11372, 2, Centre-S peak, (17°24'S, 145°49'E), 1500m, SMVFT, EW/QM, 8.xi.1981. QMMO9914, 2, R. Raven, 6.iv.1978, QMMO48463, 1, Rf., GM, GT, 8.xii.1988, QMMO48763, 8, Rf., under logs, KM, 1.iv.1978, Atherton Tbld., Boonjie Scrub, ESE Malanda (17°24'S, 145°43'E), 700m; QMMO26082, 2, Mt Hypipamee NP, The Crater, N Ravenshoe (17°25'S, 145°29'E), 950m, Rf., under logs, JS, DP, 13.x.1988; QMMO56596, 2, Mt Hypipamee NP, The Crater, N Ravenshoe (17°25'S, 145°29'E), 980m, KM, 16.iii.1994; QMMO46333, 1, Hugh Nelson Ra., N of Ravenshoe (17°27'S, 145°29'E), 1100m, J. Short, P. Davie, 31.x.1993; QMMO48038, 2, Atherton Tbld., 7km SW Millaa Millaa, Kjellberg Rd (17°33'S, 145°33'E), 1050-1100m, Rf., GM, DC, DY, 27.iv.1982; QMMO16220, 3, Palmerston Hwy, Fishers Ck (17°34'S, 145°53'E), 100m, Rf., litter, JS, 28.ix.1980; QMMO48034, 1, Ravenshoe, NE at Mt Fisher (17°34'S, 145°34'E), 1000-1200m, Rf., GM, DY, 5.v.1983; QMMO6902, 1, Palmerston Hwy (17°35'S, 145°45'E), 500m, MB; QMMO48049, 1, Palmerston NP (17°35'S, 145°42'E), 350-400m, Rf., GM, 2.i.1990; QMMO16229, 1, Palmerston Hwy, Douglas Ck (17°36'S, 145°43'E), 500m, Rf., litter, JS, 28.ix.1980; QMMO48059, 1, Atherton Tbld., 12km SW Millaa Millaa, Massey Ck (17°37'S, 145°33'E), 1000m, Rf., among litter, GM, DY, 4.v.1983; QMMO48412, 1, Atherton Tbld., 25km SE Millaa Millaa, Downey Ck (17°39'S, 145°46'E), 400m, Rf., GM, GT, 7.xii.19888; QMMO11841, 1, Ravenshoe, 20km S (17°46'S, 145°33'E), 780m, Rf., S van Dyck, K. Plowman; QMMO48002, 2, Tully, 11km N, upper Boulder Ck (17°50'S, 145°54'E), 800m, Rf., GM, GT, HJ, 4.xii.1989; QMMO30449, 1, Tully, Tabletop Ra. (17°53'S, 145°48'E), 80m, C. Welzel; QMMO60895, 2, Tully, 15km NE, along Mission Beach Rd (17°54'S, 146°04'E), 20m, Rf., under logs, R. Crookshanks, L. Free, 12.xii.1997; QMMO20180, 1, Tully, W, Tully R. valley (17°55'S, 145°50'E), 20m, JS, DP, 9.vi.1983; QMMO55680, 3, Tully, E at Mt Mackay (17°57'S, 145°58'E), under logs and rocks, J. Leroi; QMMO17460, 1, Cardwell Ra., slopes of Mt Pershouse (18°14'S, 145°47'E), 1000m, Rf., under log, KM; AMSC5545, 1, 32km NW Cardwell, in ranges at 1050m, ex C. Hedley; AMSC106675, 1 Telegraph Ra., on road to Cashmere via Cardwell; AMSC106755, 3, Kuranda, near Cairns, W. Day; AMSC106752, 2, Mulgrave R., S of

Cairns, Macleay, ex Cox coll; AMSC106754, inland from Cairns, Allen, i.1914; AMSC172709, 1, L. Eacham, Rf., ex. F.E. Allen; AMSC106773, 3, Johnstone R., in dense scrub, SJ, xii.1908; AMSC106763, 3, near Innisfail, ex. C. Horton, xii.1959; AMSC106762, 1, Cairns, back of Carrington, w. Black, ex Cox coll; AMSC106753, 1, Bellenden Ker Ra.; AMSC106756, 1, Tinaroo Scrubs, SW Cairns, SJ, xii.1908; AMSC106758, 1, Wongabel SF., c.8km S Atherton, P. Colman, iii.1959; AMSC106761, 1, Cairns, C.J. Wild; AMSC106760, 1, Atherton, ex. Atherton High School, v.1959; AMSC106757, 6, Tinaroo Scrub, Atherton district, in damp places, SJ, xi.1908; AMSC106795, 2, Mulgrave R., ex Macleay Museum; AMSC76588, 2, Little Mulgrave Scrub, near Gordonvale, G. Coates; AMSC106772, 2, Daintree R., 40km N Mossman, L. Price, x.1958; AMSC106764, 4, Yungaburra, Atherton Tbld., A.J. Marsh; AMSC106797, 1, Mt Alexander, near Mossman; AMSC106796, 1, Babinda area, near Innisfail, A.E. Johnson, 1964; AMSC106774, 14, Mulgrave R., W. Froggatt, ex Macleay Museum; AMSC124130, 3, Coquette Point, Innisfail, B. Collins, 1979; AMSC149360, SF at Greenhaven, Palmerston Hwy, under wood on track in Rf., IL, 9.x.1985; AMSC105538, 5, L. Eacham, 18.ix.1949; AMSC172705, 3, Belson's Scrub, Atherton Tbld., ex F.E. Allen; AMSC127071, 1, Jarrah Creek, at Tully-Cardstone road crossing, W of Tully, in flood debris on creek bank, W.F. Ponder & IL, 27.ix.1980; AMSC125806, 1, Charmillin Creek at Tully Falls, NVF, IL, 28.ix.1980; AMSC117978, 1, Jordan Goldfield, off Palmerston Hwy, near Innisfail, under log, IL, 10.vi.1973; AMSC158708, 1, in garden between Gordonvale and Cairns, 25.iv.1973, ex M. Shea; AMSC168511, 2, W of Cape Tribulation, 740m, granite outcrop in Rf., *Pitta* predation, HD, ix.1991.

DESCRIPTION. Shell large to very large, diameter 33-50mm (mean 40.19mm) with 5 1/8+ - 6 5/8 (mean 5 3/4) normally coiled whorls. Apex and spire moderately to strongly elevated, height 26.10-42.50mm (mean 33.08mm), H/D ratio 0.70-0.94 (mean 0.82). Protoconch of 2 whorls, sculptured with very weak radial growth lines. Post-apical whorls with fine, obliquely to radially disposed, crowded periostracal ridges occasionally arranged in a chevron pattern, not continuous on base. Base rounded with distinct excavation around umbilicus, sculptured with fine radial growth lines. Shell periphery rounded, body whorl inflated, descending rapidly for a short distance behind aperture. Aperture subovate and strongly inclined from shell axis. Umbilicus narrow, more than two-thirds covered by lip. Colour brown to dark brown with two lighter coloured bands, one below the suture and one at the shell periphery; rarely without bands and two toned: dark yellow above and brown to black below the periphery. Lip and behind aperture brown to dark brown. Based on 97 measured adults.

Genitalia (Fig. 2A,B) with hermaphroditic duct (GD) entering talon (GT) laterally; talon head knob-like. Prostate (DG) and uterus (UT) without unusual features. Short, relatively long, free oviduct (UV) and short barrel-shaped vagina (V), internally with longitudinal thickenings. Spermatheca (S) with long stalk and clavate head that reaches the base of a rather elongate albumen gland (GG). Vas deferens (VD) a thin tube, entering epiphallus (E) through a simple pore; a long tapered, muscular epiphallic flagellum (EF) present at junction. Epiphallus relatively short, reflexed with thin muscular ascending arm and shorter thick descending arm; descending portion with short, fleshy, ridge-like pilasters (EPP) internally; knob-like epiphallic caecum (EC) present about halfway along ascending arm. Penial retractor muscle (PRM) inserted apically on descending arm of epiphallus. Epiphallus entering penis through sculptured, cylindrical verge (PV); epiphallic pore (EP) terminal on verge. Penis (P) relatively long (2 times length of vagina), cylindrical, folded within moderately strong sheath (PS). Penial chamber with crowded, diamond-shaped to sub-rectangular pustules (PPR) in top third and fleshy, longitudinal thickenings (PPL) in lower two thirds and continuing into short atrium (Y).

Animal colour grey to dark grey and almost black in parts (Fig. 4). Head wart present. Based on 3 dissected adults, QMMO11292, MO11312.

DISTRIBUTION AND HABITAT. Wet Tropics Biogeographic Region from just south of Cooktown to north-west of Cardwell (Fig. 5); under logs in rainforest usually above 400m.

REMARKS. The shell of *Gnarosophia bellendenkerensis* varies in size, shape and colour throughout its range with some evidence of local geographic consistency in these characters (Fig. 3). Specimens from the Atherton Tbld. (*pterinus-castanea* forms, Fig. 3G-L) are smaller and darker in base colour than most due to the greater extent of the brown suffusion that largely obscures the subsutural yellow spiral band; specimens from the Gordonvale-Innisfail area (typical *bellendenkerensis*, Fig. 3A-C) tend to be very large with the two yellow spiral bands more prominent; and specimens from the Cardwell Ra. (*beddomae* form, Fig. 3D-F) are moderately large in size but with no brown suffusion separating the two yellow spiral bands, causing the shell to take on the bipartite colour pattern (yellow above, brown below) more commonly seen in *Hadra bipartita* and its allies.

FIG. 4. *Gnarosophia bellendenkerensis*, QMMO60242, Mt Lewis, col. R. Crookshanks.

There was, however, little discernible differentiation in reproductive anatomy and shell microsculpture between these forms. Hence, while the shell variation might indicate speciation trends in biogeographically isolated populations, there is insufficient morphological evidence to recognise more than one species.

Unfortunately there was no preserved material of the *Helix beddomae* form from the Cardwell Ra. available. This form of *G. bellendenkerensis is* of particular interest since it is an isolated southern population and has the most radical alteration in shell colour. A study of its soft parts may hold clues as to the nature of evolutionary trends in the species. Interestingly, the Cardwell Ra. is otherwise of special significance for land snails through the presence of the unusual helicarionid, *Theskelomensor creon* Solem, 1963.

DISCUSSION

Gnarosophia bellendenkerensis has peculiarities that make it both phylogenetically and biogeographically significant. On the basis of its genital structures and the presence of an eversible headwart, it belongs to the Camaeninae. Comparison of its reproductive anatomy with that of *Camaena cicatricosa* (Muller, 1774) (the type species of the type genus of the Camaenidae) from Hong Kong (Solem, 1992) shows that the basic plans are almost identical. *G. bellendenkerensis* has an epiphallic caecum developed about halfway along the epiphallus but otherwise has very similar structures (e.g. long convoluted free oviduct, clavate spermathecal head, Fig. 2A) to that of the Asian species. Perhaps more significant is the form of the penis interior. Both species have a rugosely sculptured verge with terminal pore, and a pustulated upper chamber wall changing to a series of longitudinal ridges lower down and continuing into the atrium (Fig. 2B).

The striking similarity of the reproductive systems of these two species, coupled with the suggested origins of the eastern Australian Camaenidae as post-Miocene immigrants from the land masses to Australia's north (Bishop, 1981; Solem 1992; 1998) suggests that *G. bellendenkerensis* is a basal representative of the eastern Australian camaenid lineage that first colonised the Australian land mass. The lack of morphologic change in characters from those present in the extralimital species might be explained by evolution under basically stable environmental conditions since colonisation.

In spite of its wide occurrence in the Wet Tropics, it is nonetheless an environmentally restricted species in that it occurs chiefly above 400m. Confirmed recent records of lowland occurrences are few and are usually associated with riparian situations. There is a strong inference that these individuals were washed from higher altitudes and exist opportunistically in lower habitats. A similar altitudinal distribution was outlined for the helicarionid slug *Thularion semoni* von Martens, 1894 (Stanisic, 1993a) and also characterises members of the Pupinidae and Rhytididae (Stanisic, unpubl.). These examples are not unexpected and reflect the general altitudinal stratification of the Wet Tropics biota (Webb & Tracey, 1981; Keast, 1981). This phenomenon is usually particularly exemplified by the many cases of high mountain top endemics (Monteith, 1980; Stanisic, 1987; 1993b).

In the case of *G. bellendenkerensis* (and some other species of Wet Tropics land snails) a somewhat less marked altitudinal restriction is no less significant and infers the existence of a strong altitudinal biogeographic barrier. In fact the 400m contour represents a transition zone between the biota of the lowland humid complex mesophyll vine forests and that of the cooler upland and highland communities (Webb & Tracey, 1981). These latter communities were presumably more widespread at lower altitudes in the time-frame suggested for the first appearance of the camaenids in eastern Australia. With the drift of the continent into lower latitudes and a related altitudinal attenuation of biotic communities in the north, species were placed under considerable selective climatic pressure to adapt or retreat. In the case of *G. bellendenkerensis* populations appear to have followed the

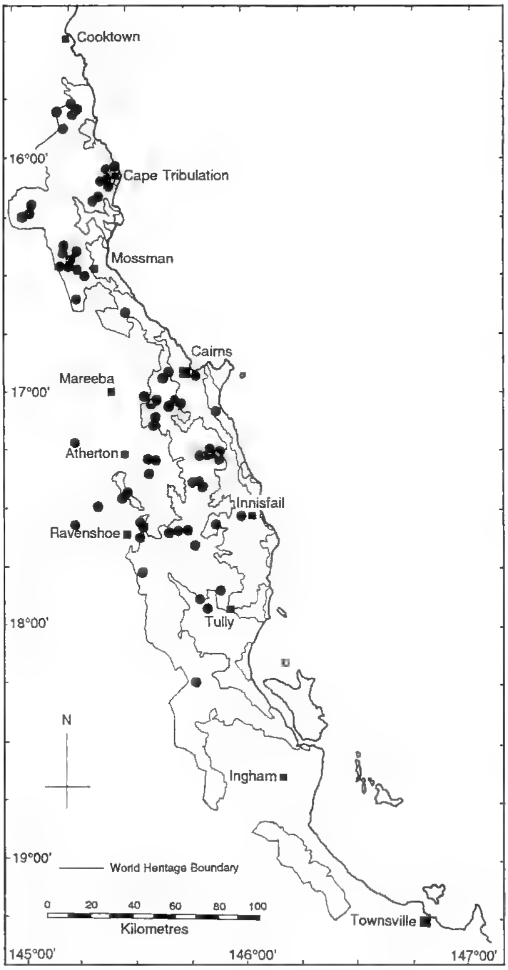

FIG. 5. Distribution map of *Gnarosophia bellendenkerensis*.

upland retreat of the moist, cooler communities with little evidence of transition to the hotter, drier lowland forests, in spite of significant pressure to do so. This preference for the status quo in environmental conditions indicates a lack of adaptability but might also explain the lack of apparent morphological change in the species throughout its range.

Close study of the distribution of *G. bellendenkerensis* reveals that there is a series of discrete populations centred on the various rainforest blocks (refugia) in the Wet Tropics (Fig. 5). These isolates represent survivors of the Pleistocene restriction of mesic communities to very small upland and gully head refugia (Webb & Tracey, 1981; Nix, 1991). Though subsequent dispersal under more favourable climatic conditions may have led to expansion and even inter-block dispersal of populations, some climate-induced barriers between currently recognised blocks have persisted for a considerable period of time (e.g. Cardwell Ra.).

Hence, in spite of the lack of obvious morphological differences in these populations of *G. bellendenkerensis*, it could be expected that long-term isolation of populations has led to some level of genetic drift. Molecular studies will be needed to investigate the extent of these changes. The absence of sympatric congeners has meant that there has been little selective pressure for change from the base pattern in the terminal genitalia.

The relationship of *G. bellendenkerensis* to other hadroids is still problematic. The periostracal microsculpture bears some resemblance to that seen in some of the more southerly occurring hadroid species grouped in *Sphaerospira* by Smith (1992). These include *S. fraseri* (Griffith & Pidgeon, 1833) from southeastern Queensland and *S. informis* (Mousson, 1869) from mid-eastern Queensland and form part of a 'dark-animal' group (foot, mantle and tentacles grey to black) within *Sphaerospira* as opposed to species that display variously coloured animals (shades of mustard, pink, red, brown and orange on the foot, tentacles and neck) (Stanisic, 1996c). These latter species were previously placed in *Varohadra* Iredale, 1933 (+ *Figuladra* Iredale, 1933), *Bentosites* Iredale, 1933 and *Gnarosophia* Iredale, 1933 by Iredale (1933, 1937). *Monteithosites* Stanisic, 1996 from Bakers Blue Mountain and Hanns Tbld. (Wet Tropics outliers) also has a coloured animal (red and brown). Stanisic (1996b,c) discusses this dichotomy in animal colours in some detail and suggests that these two groups are in fact biogeograpically and phylogenetically distinct. [N.B. The type of *Varohadra* (= *Helix oconnellensis* Cox, 1871) is in fact a dark animal species and was associated with coloured animal species by Iredale (1937) without explanation. It will be shown elsewhere that this species is more closely related to *Sphaerospira* s.s.].

It is noteworthy that *S. fraseri* has a similar internally structured penis to *G. bellendenkerensis* (apical pustules and basal longitudinal pilasters) although a verge is absent in the former. A similar pattern is also present in other dark animal species e.g. *S. informis* (Mousson, 1869), *S. mortenseni* (Iredale, 1929) and *S. blomfieldi* (Cox, 1864). In contrast many of the coloured animal forms have an extra pustular zone added to the base of the penial chamber and extensive pilaster modifications in the upper penial chamber (Stanisic, unpubl.). In that they correlate with basic differences in the periostracal microsculpture of the two species groups, these anatomical variations may be shown to be fundamental phylogenetic differences (rather than alterations related to sympatric species interactions) once additional studies are complete.

ACKNOWLEDGEMENTS

Thanks are due to the Malacology Section, Australian Museum, Sydney for the loan of type material; to Ms Alison Francis (formerly Hill) for the anatomical drawings; Ms Kylie Stumkat for producing the scanning electron micrographs; and Mr Jules Leroi and Mr Andrew Hugall for completing the shell measurements.

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FIVE NEW SPECIES OF *APTENOCANTHON* MATTHEWS (COLEOPTERA: SCARABAEIDAE: SCARABAEINAE) FROM TROPICAL AUSTRALIA, WITH NOTES ON DISTRIBUTION

R.I. STOREY & G.B. MONTEITH

Storey, R.I. & Monteith, G.B. 2000 12 31: Five new species of *Aptenocanthon* Matthews (Coleoptera: Scarabaeidae: Scarabaeinae) from tropical Australia, with notes on distribution. *Memoirs of the Queensland Museum* **46**(1): 349-358. Brisbane. ISSN 0079-8835.

Five new species of the flightless scarabaeine genus *Aptenocanthon* Matthews are described from northern Australia: *jimara* sp. nov. from the Northern Territory; *kabura* sp. nov., *wollumbin* sp. nov., *winyar* sp. nov. and *speewah* sp. nov. from mountains in the wet tropics of northern Queensland. A key is given to the eight species in the genus. *A. jimara* is the first record of the genus away from the east coast. Biology and distribution are discussed. □ *Coleoptera, Scarabaeidae, Scarabaeinae, Aptenocanthon, dung beetles, taxonomy, rainforest, flightless.*

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Matthews (1974) erected *Aptenocanthon* to contain two small, flightless, canthonine dung beetles from mountain rainforests in central, coastal New South Wales, namely *A. hopsoni* (Carter) from the Barrington Tops region and *A. rossi* Matthews from the Blue Mountains. The distributional dimension of the genus was expanded radically with the later discovery of *A. monteithi* Storey on the summit of the highest mountains in tropical Australia, in the Wet Tropics region of northern Queensland, almost 2,000km north of the NSW species (Storey, 1984). Subsequently, intensive surveys of all the mountain systems in the Wet Tropics by the Queensland Museum, have revealed another 4 new species, all with allopatric distributions on other high altitude mountain ranges. In addition, an undescribed species has been located in the ANIC collection from lowland, monsoonal rainforest in the Northern Territory.

When Storey described *A. monteithi* he noted that it deviated from the generic definition in several ways. There is also considerable morphological diversity among the new species described here, and some of them further extend the accepted concept of *Aptenocanthon*. However, they all share a similar body form, and for those where males are known, all have a similar form of the fore tibial apex with its inner angle expanded and bearing a short brush of stiff setae bent downwards at right angles to the upper tibial surface. A proper assessment of the status of these putative species of *Aptenocanthon* should include a comprehensive consideration of related genera in the mentophiline section as defined by Matthews (1974). Since such studies are in progress, at several levels, by other workers, this paper simply names and diagnoses these species to place them on record as part of the recently discovered mountain diversity of the Wet Tropics.

METHODS AND MATERIALS

Terminology and format for descriptions are similar to those used by Storey (1984). The use of the term 'hypomeral stria' follows that of Reid & Storey (2000) for *Temnoplectron* Westwood.

The following abbreviations for collections are used: ANIC, Australian National Insect Collection, Canberra, Australia; HAHC, H. & A. Howden Collection, Ottawa, Ontario, Canada; QM, Queensland Museum, Brisbane, Australia; QPIM, Department of Primary Industries, Mareeba, Qld, Australia. Collectors are abbreviated as follows: DC, D.J. Cook; GM, G.B. Monteith; SM, S.R. Monteith; GT, G.I. Thompson; HJ, H.A. Janetzki; SH, S. Hamlet; DY, D.K. Yeates; PB, P. Bouchard.

SCARABAEIDAE
SCARABAEINAE
SCARABAEINI
CANTHONINA

Aptenocanthon Matthews

Aptenocanthon Matthews 1974: 93.

TYPE SPECIES. *Panelus hopsoni* Carter, 1936 by original designation.

KEY TO SPECIES OF *APTENOCANTHON*

1. Ventral aspect of prothorax with a short hypomeral stria on each side extending forward a short distance from the hind margin towards the femoral depressions and parallel to the pronotal margin. 2

   Ventral aspect of prothorax without such hypomeral striae; north Queensland 6

2. Dorsal surface of head with distinct recurved setae; epipleural line strongly carinate; pygidium with large circular punctures; Northern Territory . *jimara* sp. nov.

   Dorsal surface of head glabrous; epipleural line not strongly carinate; pygidium without circular punctures; eastern Australia 3

3. Pygidium with a deep transverse groove across upper margin, terminating in a pit at each end; pseudepipleural margin not carinate, broadly rounded; north Queensland . . . . *speewah* sp. nov.

   Pygidial groove, if present, not terminating in pits at each end; pseudepipleural margin usually carinate 4

4. Pseudepipleura of elytra each with 2 distinct short striae; dorsal part of eye very short, wider than long; north Queensland . . . . *wollumbin* sp. nov.

   Pseudepipleura of elytra each with 1 distinct stria; dorsal part of eye longer than wide; NSW 5

5. Elytra with intervals flat, glabrous; lateral pseudipipleural margins sharply defined basally; outer edge of epipleura strongly sinuate . . . *hopsoni* (Carter)

   Elytral with intervals convex, densely setose; lateral pseudepipleural margins not carinate, broadly rounded; epipleura normal . . . . *rossi* Matthews

6. Pygidium with a distinct groove along its basal edge; elytral striae strongly impressed and catenulate . . . . *kabura* sp. nov.

   Pygidium uniformly convex, without grooves; elytral striae weakly impressed, not catenulate 7

7. Striae on dorsal surface of elytra fine but distinct, each with small punctures present; intervals slightly convex; larger species, length >5mm . . . . *winyar* sp. nov.

   Striae on dorsal surface of elytra almost effaced, impunctate; intervals flat; smaller species, length <5mm . . . . *monteithi* Storey

Aptenocanthon jimara sp. nov.
(Figs 1, 2E, 6A)

MATERIAL. HOLOTYPE: ♀, Northern Territory, 12°47'S 132°51'E, Baroalba Spring, 20.xi.72, R.W. Taylor, rainforest, berlesate. ANIC 470 (in ANIC).

DESCRIPTION. *Female.* Total length 3.5mm; maximum width 2.7mm; colour brown, edges of elytra a little lighter, antennae yellow.

Head. Clypeal teeth small, shallow, with broad U-shaped excavation between; rest of margin feebly convex to the obtuse, indistinct genae; anterior edge indistinctly margined. Dorsal surface subnitid, reticulate near clypeal apex, moderately punctate, each puncture separated by about half a diameter; punctures each with a short anteriorly directed seta; a circular marking near the inner apex of each eye, about the size of dorsal portion of eye, nitid, impunctate. Dorsal portion of eyes small, about 5 facet rows in width, separated by about 8 eye widths; canthus incomplete. Apical segment of labial palpi small, narrow about one-third length of second segment.

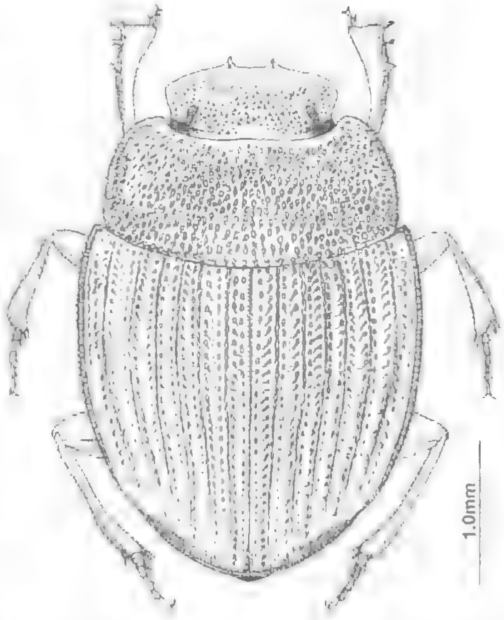

FIG. 1. *Aptenocanthon jimara*, ♀ holotype, dorsal view.

Pronotum. Surface slightly flattened, about 2.3 times as wide as long. Anterior angles quadrate, apices acute; lateral angles broadly obtuse, rounded; posterior angles obtuse. Anterior edge finely margined on lateral one-third only; posterior edge not margined; lateral edge with narrowly doubled margin from lateral angles to posterior angles. Surface nitid with large ocellate punctures each separated by less than one diameter, most with a short recurved seta.

Elytron. Striae shallow, narrow, crenulate, punctures not discernible. Intervals nitid, convex in centre, with large ocellate punctures along margins next to striae; each puncture with a short seta recurving towards centre of interval. Dorsal surface with 7 striae (seventh visible in basal one-third), strongly deflexed outside seventh stria to form a pseudepipleuron which is carinate and distinct for about four-fifths length of elytron. Pseudepipleuron with 2 distinct striae and possibly a third next to margin with epipleuron; epipleural border strongly carinate.

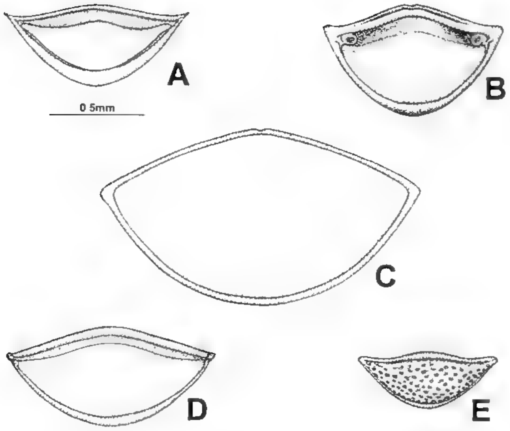

FIG. 2. *Aptenocanthon* spp., pygidium. A, *kabura* sp. nov.; B, *speewah* sp. nov.; C, *winyar* sp. nov.; D, *woolumbin* sp. nov.; E, *jimara* sp. nov.

Distinct setate punctures on pseudepipleural surface, not ocellate; setae shorter than on dorsal surface. Epipleuron wide at base, narrowing gradually towards apex, a little depressed at level of metatibia; surface reticulate, with large shallow punctures and fine indistinct setae.

Pygidium. Broad, apex rounded, with basal groove distinct on central one-half only, surface with medium-sized punctures, each with a fine seta.

Venter. Ventral surface of pronotum with hypomeral striae distinct, extending from posterior edge to about one-half distance to anterior femoral depressions; surface with medium-sized punctures each with a short seta. Mesosternum short. Meso- and metasternum nitid, subnitid laterally on metasternum, with numerous ocellate punctures each with a short seta, punctures and setae stronger posteriorly. Sternites finely reticulate, visible segments 2-5 with a row of medium-size punctures along anterior edge, and along posterior edge laterally; segment 6 with similar punctures over entire surface; punctures with short, fine setae.

Legs. Fore tibiae with inner apical spur short, acute, ventral surface of femur with dense medium-size punctures with short recurved setae. Mesofemur nitid with small punctures each with a fine seta. Metafemora with numerous punctures each with a fine seta.

Male. Not known.

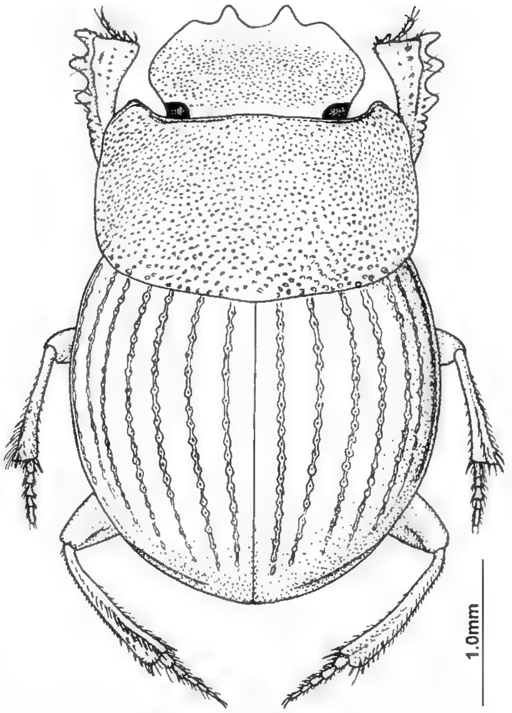

FIG. 3. *Aptenocanthon kabura*, ♀ holotype, dorsal view.

REMARKS. The unique holotype is from leaf litter in a remnant rainforest patch fed by a permanent spring system a little to the east of Nourlangie Rock in Kakadu National Park. This is the only known occurrence of the genus away from the east coast of the continent. The species can be easily recognized by the obvious dorsal setae on head and elytra, the distinct hypomeral carina on the ventral side of the pronotum, and the presence of 6 visible sternites on the abdomen. It has some resemblance to a small species of *Tesserodon* Hope, and its generic placement should be regarded as provisional. The specific name is an Aboriginal word for hair.

Aptenocanthon kabura sp. nov.
(Figs 2A, 3, 6B, 8)

MATERIAL. HOLOTYPE: ♀, QMT54702, Qld, Mt Finnigan summit, via Helenvale, 3-5.xii.1990, D. Cook, G. Thompson & L. Roberts, 1050 m, pitfall traps. In QM; Paratype: ♀, same locality, 19-22.iv.1982, GM, DY & DC, rainforest pitfall trap (ANIC Data No 25 017214). In QPIM.

DESCRIPTION. *Female.* Total length 3.8mm; maximum width 2.5mm; colour black except head, legs, abdominal sternites dark brown; antennae yellow.

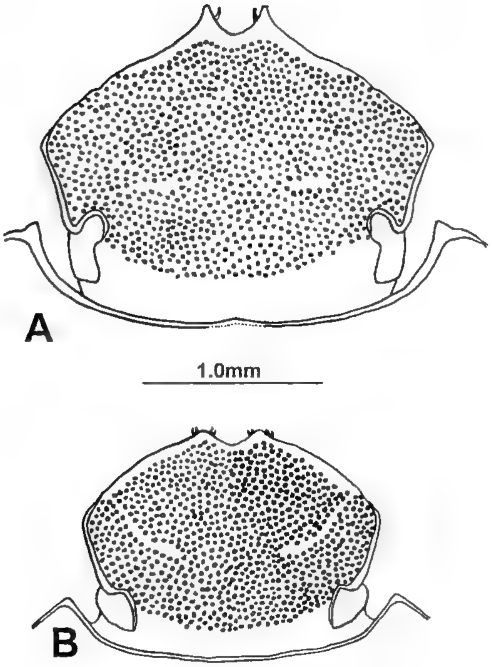

FIG. 4. *Aptenocanthon* spp., head, dorsal view. A, *winyar* sp. nov.; B, *woolumbin* sp. nov.

Head. Clypeal teeth short, apices rounded, U-shaped excavation between, also smaller U-shaped emarginations just lateral to each tooth; rest of margin very feebly convex to genae which are obtuse, rounded; edge finely margined. Dorsal surface nitid, glabrous, with dense, medium-size punctures separated by less than one diameter, reduced near clypeal margin, on clypeal teeth and on small triangular markings central from each eye. Dorsal portion of eyes short about 3 facet rows long, maximum width 6 facet rows; eyes separated by about 6 eye widths. Labial palpi with terminal segment small, cylindrical, about one-half length of second segment.

Pronotum. Slightly flattened; anterior angles quadrate, apices subacute; lateral angles broadly obtuse; posterior angles obtuse; anterior edge finely margined; lateral edge with single margin; posterior edge unmargined. Dorsal surface nitid, glabrous with numerous medium-size punctures, separated by 1-2 diameters, reduced in centre of disc and becoming a row of large ocellate punctures along posterior margin.

Elytron. Dorsal surface nitid with 7 impressed striae, each broad, shallow, strongly catenulate with small punctures; intervals weakly convex, with scattered fine punctures each with a very fine seta, more obvious towards apex. Surface deflexed outside of 7th stria forming a pseudepipleuron about three-quarters length of elytron; its surface finely reticulate with one basal stria near dorsal margin, a second stria near the centre and traces of a third adjacent to epipleuron. Epipleuron finely reticulate, broad, widest near centre, gradually narrowing to apex.

Pygidium. Broad, convex, apex rounded, with strong groove along basal margin and weaker groove near remaining margin, thus enclosing disc. Surface nitid, glabrous with scattered small punctures.

Venter. Prosternum subnitid with large ocellate punctures in posterior half; hypomeral striae absent. Mesosternum broad, nitid with large horseshoe-, or circular-shaped punctures laterally. Metasternum nitid, central portion with fine punctures, posterior margin and lateral wings with medium to large horseshoe-shaped punctures. Abdominal sternites nitid, fifth and sixth visible segments fused in centre half, segments 2-4 with large circular punctures along anterior margins, these also present over entire surface of segment 5/6.

Legs. Inner apical spur of protibiae short, acute; all femora nitid with small finely setate punctures.

Male. Not available.

REMARKS. This species has elytra similar to *A. hopsoni* Carter but has a different shaped anterior margin of the head, wider dorsal portions of the eyes and, like *A. monteithi* Storey and *A. winyar* sp. nov., lacks hypomeral striae on the underside of the prothorax. The species is known only from the summit of Mt Finnigan, an isolated mountain south of Cooktown which has many other endemic species. It appears to be genuinely rare because intensive collecting on several visits has yielded only two specimens, both in pitfall traps set in rainforest at 1050m.The specific name is an Aboriginal word for head, in reference for the unusual shape of the anterior margin of the head.

Aptenocanthon monteithi Storey, 1984
(Figs 6C, 8)

NEW MATERIAL. (40) N Qld: 1♂, Bellenden Ker, Summit TV Station, 1560m, 29.iv.-2.v.1983, GM & DY; 1♂1♀, same data, litter berlesate; 2♀, same locality, 28.viii.- 8.x.1991,GM&HJ, pitfall traps; 2♀, Lambs Head, 10km W Edmonton, 1200m, 8.i.-22.ii.1990, GM,GT&HJ, rainforest pitfalls; 1♂1♀ same data except 10.xii.1989-

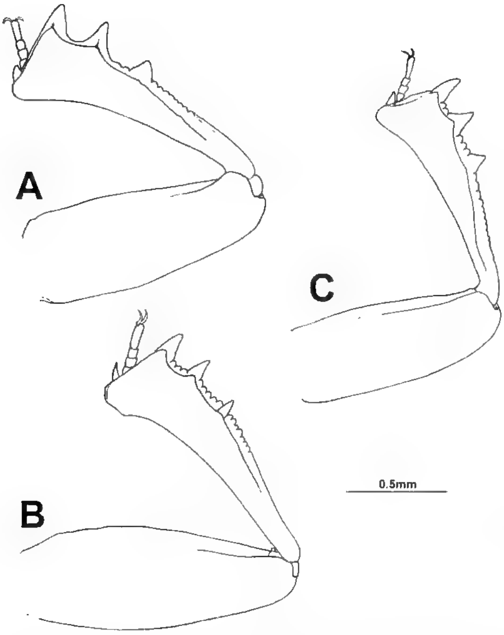

FIG. 5. *Aptenocanthon* spp., male fore legs, dorsal view. A, *speewah* sp. nov.; B, *winyar* sp. nov.; C, *wollumbin* sp. nov.

8.i.1990; 4♂ Lamb Range, 19km SE Mareeba, 1200m, 3.x.1988, GM & GT, litter berlesate and pitfall;1♂1♀, Kauri Ck, Lamb Ra, 1190m, 6-10.ii.1998, GM & DC, fish pitfall; 1♂1♀, Mt Fisher summit, 1360m, 8.ii.1998, GM & DC, litter berlesate; 18♂5♀, Mt Bartle Frere, top camp, 1500m, 29-30.xi.1998, GM, dung trap. In QM, QPIM, HAHC.

REMARKS. These new records do not extend its range beyond the four mountain massifs from which it was originally described. Its altitudinal range is the highest in the genus, not having been recorded below about 1100m.

Aptenocanthon speewah sp. nov.
(Figs 2B, 5A, 6D, 7A, 8)

MATERIAL. HOLOTYPE: ♂, QMT54713, N Qld, 16°55'S 145°40'E, Mt Williams, 900-1000m, 2-3.xii.1993. Cook, Monteith & Janetzki. In QM. PARATYPES: (86) 10♂25♀, same data as holotype; 11♂16♀, same locality, 1000m, 27.xi.1997-6.ii.1998, GM & DC, rainforest pitfall; 1♂, same locality, 28.xi.1997, GM, berlesate ex litter; 13♂10♀, same locality, 27-28.xi.1997, GM & DC, dung trap. In QM, duplicates in ANIC, HAHC, DPIM.

DESCRIPTION. *Male.* Total length 4.0-4.2 mm; maximum width 4.2mm; colour black except head, legs, abdominal sternites dark brown. Antennae yellow.

Head. Clypeal teeth short, blunt, with U-shaped excavation between; rest of margin uniformly convex to genae; edge finely margined. Head surface nitid, glabrous, with numerous punctures separated by 1 diameter or a little less. Dorsal portion of eyes about as wide as long (7 facets), separated by about 10 diameters. Labial palpi with apical segment small, blunt, about half diameter and about two thirds length of second segment.

Pronotum. Weakly convex, ratio of width at base (widest point) to length at middle about 1.7. Anterior angles quadrate, apices weakly protruding; lateral angles broadly obtuse; posterior angles obtuse, subquadrate. Whole perimeter finely margined. Surface nitid, glabrous, covered with medium-size simple punctures, separated by 1-2 diameters, smaller and less dense in centre of disc; punctures effaced along lateral edges.

Elytron. Convex, finely reticulate, with 7 striae on dorsal surface; stria 7 terminating at about half elytral length; striae simple, practically impunctate on disk but with small punctures towards sides, intervals flat, with fine punctures. Pseudipleural carina absent but elytron roundly deflexed outside seventh stria. Epipleuron broad, curved outwards, merging with remnant of stria 8; surface finely reticulate, glabrous, impunctate.

Pygidium. Nitid, smooth, very finely punctate; a deep transverse groove runs parallel to upper margin and terminates in a pit at each end.

Venter. Prosternum reticulate, with a group of obscure ocellate punctures near posterior edge; hypomeral striae present, extending from hind margin about two thirds distance to femoral depressions. Mesosternum nitid, posterior half with sparse ocellate punctures. Metasternum nitid, very finely punctate on central portion with impressed, close-spaced, horseshoe-shaped punctures on lateral wings. Abdominal sternites reticulate, visible segments 5 and 6 semi-fused in centre, segments 2-5 with obscure medium-size punctures laterally on anterior margin, segment 6 with large, scattered punctures over most of surface.

Legs. Fore tibia with inner apical angle produced and bearing a tuft of downward-directed bristles; inner apical spur short, wide, blunt. All femora nitid with very fine punctures, glabrous.

Female. Lacking expanded fore tibial angle and with spur longer, narrow, acute.

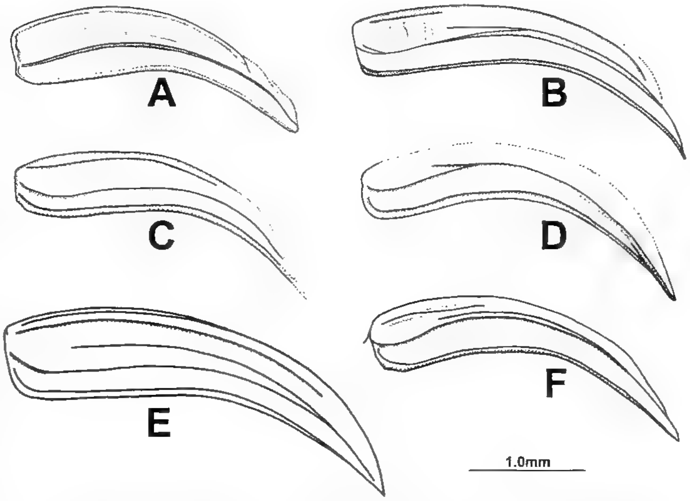

FIG. 6. *Aptenocanthon* spp., epipleural region of left elytron, anterior to left. A, *jimara* sp. nov.; B, *kabura* sp. nov.; C, *monteithi* Storey; D, *speewah* sp. nov.; E, *winyar* sp. nov.; F, *woolombin* sp. nov.

REMARKS. This species lacks the carinate pseudepipleural fold along the edge of the elytra which is normally typical of *Aptenocanthon.* However the elytra curve from the dorsum to the plane of the pseudepipleural surface at the same point laterad of stria 7. This indicates that absence of the carina is secondary. The southern species, *A. rossi,* has also lost the carinate margin. In other respects, including the male tibial structure, *A. speewah* accords with *Aptenocanthon.* The species is known only from the summit rainforest on Mt Williams, a peak which forms the eastern end of the range separating the valleys of the Barron River and Freshwater Creek 10km W of Cairns. Its name commemorates 'The Speewah', a pioneering name for the district at the northern base of Mt Williams.

Aptenocanthon winyar sp. nov.
(Figs 2C, 4A, 5B, 6E, 7B, 8)

MATERIAL. HOLOTYPE: ♂, QMT54676. Queensland: 17°23'S 145°47'E, Mt Bartle Frere, Upper Boulder Cave, 1000m, 25.xi.1994, G. Monteith, in swiftlet guano. In QM. PARATYPES: (183) Qld: 7♂ 3♀, same data as holotype; 8♂4♀, same locality except 12.v.1995, GM & D. Slaney; 1♂, same locality except 8.xii.1990, GM, GT, DC & R. Sheridan; 1♀, Mt Bartle Frere, Swiftlet Cave, 900m, 8.xii.1990, GM, GT, DC & R. Sheridan; 5♂3♀, 17°41'S 145°32'E, Vine Creek, Majors Mt, 1060m, 4-6.ii.1999, GM & DC, dung pitfall; 2♂, same data, but fungus pitfall; 1♂, same data, but fish pitfall; 1♂, same locality, 15-18.iv, GM & SM, dung pitfall; 5♂, same data, but fungus pitfall; 8♂3♀, same data, but dead insect pitfall;1♂, Upper Boulder Creek, 850m, 11km NNW of Tully, 15-19.xi.1984, GM, DC & GT; 1♀, same locality, 4.xii.1989, GM, GT & HJ, pitfall, 800m; 1♂ 1♀, 17°54'S 145° 51'E, summit 7km S of Mt Kooroomool, 1050m, 3.xi.1998, GM, dung trap, dusk 5-7.30pm; 9♂ 17♀, same locality, 3.xii.1999, GM, dung trap, night, 7.30-10pm; 38♂ 33♀, same locality, 3-4.xii.1998, GM, dung trap, night/dawn, 10pm-7.30am; 1♀, same locality, 4.xii.1998, GM, dung trap, dusk, 6-7.30pm; 12♂ 10♀, same locality, 4-5.xii.1998, GM, dung trap, night, 7.30pm-5.30am; 3♂ 1♀, same locality, 3.xii.1998, GM, DC & PB; 1♀, Mt Macalister, Cardwell Range, 850m, 18.xii.1986 - 14.i.1987, GM, GT & SH, RF, pitfall trap. In QM, with duplicates in ANIC, HAHC, QPIM.

DESCRIPTION. Total length 6.2mm; maximum width 4.2; colour brown, disc of elytra darker, antennae yellow.

Male. Head. Clypeal teeth short, subacute, close together, U-shaped excavation between; rest of margin feebly convex to genae, which are obtuse; edge finely margined. Surface nitid, glabrous, with numerous medium-size punctures separated by 0.5-1 diameter; punctures effaced along anterior margin, clypeal teeth and small elyptical marking in front of eyes. Dorsal protions of eyes small, about 8 facet rows in length and width, separated by about 10 eye widths; canthus incomplete. Labial palpi with apical segment small, narrow, cylindrical, about one-third length of second segment.

Pronotum. Convex, ratio of width at base (widest point) to length at middle about 2.4. Anterior angles quadrate, apices acute, protruding; lateral angles broadly obtuse; posterior angles obtuse, subquadrate. Anterior edge finely margined to middle; lateral edge with single margin; posterior edge with fine margin at lateral quarters only. Surface nitid, glabrous, covered with medium-size simple punctures, separated by 0.5-1 diameters, smaller and less dense in centre of disc; punctures effaced along lateral edges, indistinct horseshoe-shaped punctures along posterior margin.

Elytron. Convex, finely reticulate, with 7 striae on dorsal surface; striae fine, narrow, with small

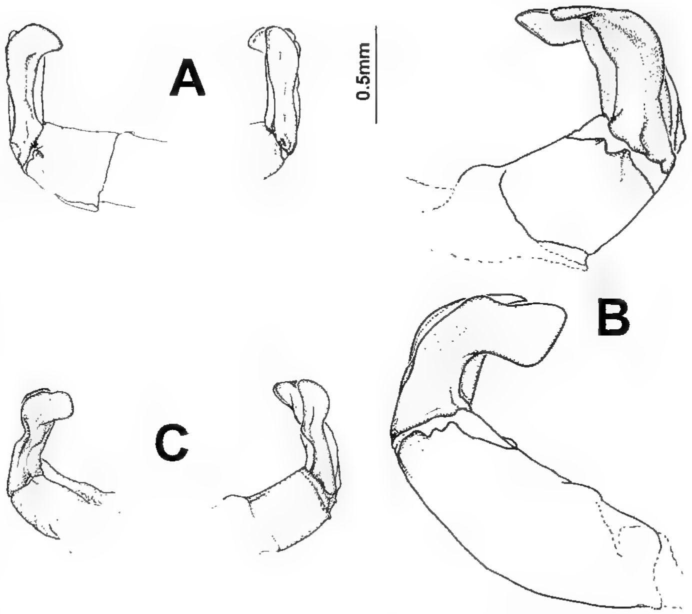

FIG. 7. *Aptenocanthon* spp., apex of aedeagus with parameres, left and right views. A, *speewah* sp. nov.; B, *winyar* sp. nov.; C, *woolumbin* sp. nov.

Elytron. Subconvex, nitid, glabrous. Seven distinct striae on dorsal surface, these narrow, finely punctate with small punctures, these vaguely crenulating striae near apex. Intervals flat, impunctate. Surface deflexed outside seventh stria forming pseudepipleuron above epipleuron, edge rounded, formed to about three-quarters length of elytron, with 2 short fine striae, surface nitid, glabrous, impunctate. Epipleuron subnitid, glabrous, broad, widest about middle then gradually narrowing to apex.

Pygidium. Convex, nitid, glabrous with scattered minute punctures. Anterior edge with distinct groove along entire length, rest of edge distinctly margined only.

Venter. Prosternum subnitid, glabrous; hypomeral striae present, running from posterior edge about one-half distance to femoral depressions, area medial of striae with narrow, crescent-shaped punctures. Mesosternum narrow, nitid, glabrous with crescent-shaped punctures on lateral one-thirds. Metasternum nitid, glabrous, centre portion with minute punctures, small and simple punctures along posterior margin, large and horseshoe-shaped on lateral wings. Abdominal sternites subnitid, glabrous, sternites 5 and 6 fused in centre half. Small circular punctures along anterior edges of segments 2-4, segment 5/6 with larger circular or horseshoe-shaped punctures on entire surface.

Legs. Fore tibia with inner apical angle produced and bearing a tuft of downward-directed bristles; spur short, blunt; anterior ventral surface of fore femora with very small punctures and posterior ventral surface with medium-size punctures. Hind tibia with a blunt, inwardly-directed tubercle at the apex. Meso- and metafemora nitid, glabrous with scattered minute punctures.

Male genitalia. As illustrated in Fig. 7C.

Female. As for male but lacking specialisation of fore and hind tibiae.

REMARKS. *A. wollumbin* sp. nov. is known only from an isolated population in the summit rainforest of Mt Elliot (1000-1200m), just southwest of Townsville, Queensland. It is very comon there and was taken using dung-baited pitfalls, unbaited pitfalls and berlesate extraction in rainforest. Unlike *A. monteithi* Storey and *A.winyar* sp. nov. from the Bellenden-Ker Range and Atherton Tablelands further north, *A. wollumbin* has hypomeral carinae on the prothorax, sternites 5 and 6 of the abdomen fused in the centre and a strong basal groove on the pygidium, as do the two NSW species *A. hopsoni* Carter and *A. rossi* Matthews. The specific name is an Aboriginal word for 'high mountain'.

DISTRIBUTION OF WET TROPICS SPECIES

With five of the eight species occurring there, the Wet Tropics is now revealed to be the centre of diversity for a genus initially thought confined to southern Australia. The range of all species is shown in Fig. 8A. All are allopatric and restricted to wet rainforests at altitudes in excess of about 900m. Three are confined to discreet summit zones of single isolated peaks: *A. woolumbin* on Mt Elliot, *A. speewah* on Mt Williams and *A. kabura* on Mt Finnigan. The remaining two, *A. monteithi* and *A. winyar*, have more extensive ranges on the mountain complexes which surround the Atherton Tableland in the central punctures, intervals very feebly convex, punctate, with fine punctures. Elytron sharply deflexed outside seventh stria forming pseudepipleuron; surface finely reticulate, glabrous, impunctate with 2 strong striae running most of length of pseudepipleuron. Epipleuron broad, constant width for three-quarters length then narrowing to apex; surface finely reticulate, glabrous, impunctate.

Pygidium. Pygidium smooth, nitid, uniformly convex and lacking grooves; surface with scattered small, shallow punctures and some transverse reticulation; a narrow raised margin present all round.

Venter. Prosternum reticulate, with a group of obscure ocellate punctures near posterior edge; hypomeral striae absent. Mesosternum nitid, with posterolateral group of ocellate punctures. Metasternum nitid, very finely punctate on central portion with ocellate punctures on lateral wings. Abdominal sternites reticulate, visible segments 5 and 6 not fused in centre, segments 2-5 with obscure medium-size punctures laterally on anterior margin, segment 6 with scattered obscure medium punctures laterally.

Legs. Fore tibia with inner apical angle produced and bearing a tuft of downward-directed bristles; inner apical spur narrow, acute. All femora nitid with very fine punctures, glabrous.

Male genitalia. As illustrated in Fig. 7B.

Female. As for male but lacking produced inner angle and bristle-tuft; fore tibial spur longer.

REMARKS. *A. winyar* sp. nov. is very close to *A. monteithi* Storey and can be distinguished by its larger size, more distinct elytral striae, more convex elytral intervals and its eye shape. It is the most widespread Wet Tropics species, ranging from Mt Bartle Frere south to the southern end of the Cardwell Range and east to the end of the Walter Hill Range. Both *A. winyar* and *A. monteithi* have been recorded on Mt Bartle Frere, however their habitats do not overlap with *A. monteithi* found only near the summit (above about 1500m) and *A. winyar* much lower (850-1000m).

There is some habitat variation over the range of *A. winyar*. On Mt Bartle Frere it has been taken only in the complete dark zone of deep, underground, erosional boulder caves, up to 20 metres below the surface. There it lives in association with mounds of bird guano which form beneath nesting colonies of the White-rumped Swiftlet (*Collocalia spodiopygius*). Persistant collecting outside the caves has failed to detect it in the epigeal habitat. By contrast, at other sites such as Vine Creek and near Mt Kooroomool it is abundant in the leaf litter and comes in large numbers to exposed baits including dung, carrion, decaying mushroom and dead insect. It is strictly nocturnal in activity.

Aptenocanthon wollumbin sp. nov.

(Figs 2D, 4B, 5C, 6F, 7C, 8)

MATERIAL. HOLOTYPE: ♂, QMT54749, Qld, Mt Elliot NP, NE Qld (Upper North Ck, 1000m), 3-5.xii.1986, G. Monteith, G. Thompson & S. Hamlet, pitfall traps. In QM. PARATYPES: (143) Qld: 36♂ 32♀, same data as holotype; 2♂ 2♀, same data but 2-5.xii.1986; 17♂ 11♀, same data but 25-27.iii.1991, GM & DC, pitfall and dung traps; 1♂ 1♀, same data but 3.xii.1986-15.ii.1987, GM, GT & SH, RF pitfall traps; 2♂ 1♀, same data but 25-27.iii.1991, GM & DC; 1♀, 19°30’S, 146°57’E, Mt Elliot summit area, 1000-1200m, 3.xii.1986, GM, GT & SH; 9♂ 11♀, same locality, 1150m, i.-26.iii.1991, A. Graham, pitfall and intercept traps, fern glade; 2♂, same locality, 13.xii.1990, A. Graham, hand collecting; 3♂ 3♀, same locality, i.-26.iii.1991, A. Graham, pitfall and intercept traps, rainforest; 1♂ 1♀, same locality, 26.iii.-12.v.1991, DC, pitfall and intercept traps, rainforest; 1♂ 1♀, same locality, 1150m, 26.iii.1991, GM & DC; 1♀, same locality,12.v.1991, DC & D. Beaty; 3♂ 2♀, 19°26’S 146°58’E, Mt Elliot, NE slope, 1000m, 5.xii.1986, GM & GT, QM Berlesate No 723, rainforest litter. In QM, duplicates in ANIC, HAHC, QPIM.

DESCRIPTION. Total length 4.0-4.6mm, maximum width 2.7-3.1mm, colour black, legs dark brown, antennae yellow.

Male. Head. Clypeal teeth small, subacute, shallow U-shaped excavation between; rest of margin feebly convex to obtuse, indistinct genae; anterior edge margined. Dorsal surface nitid, glabrous, covered with medium-size punctures separated by 0.5-1 diameters. Dorsal portion of eye, very small, about 1 facet row in length on frons; width about 3 facet rows; eyes separated by 12-13 eye widths; canthus incomplete. Labial palpi with apical segment cylindrical, narrow, short, about half the length of second segment.

Pronotum. Convex, ratio width (maximum at posterior margin) to length (at centre line) about 1.8. Anterior angles quadrate, subacute, apices feebly protruding, lateral angles obtuse, broadly rounded, posterior angles obtuse, rounded. Anterior edge completely margined, lateral edge with single margin, posterior edge margined in lateral one-quarter only. Surface nitid, glabrous with medium-size punctures separated by 0.5-1 diameters, finer in centre of disc, minute along lateral margins.

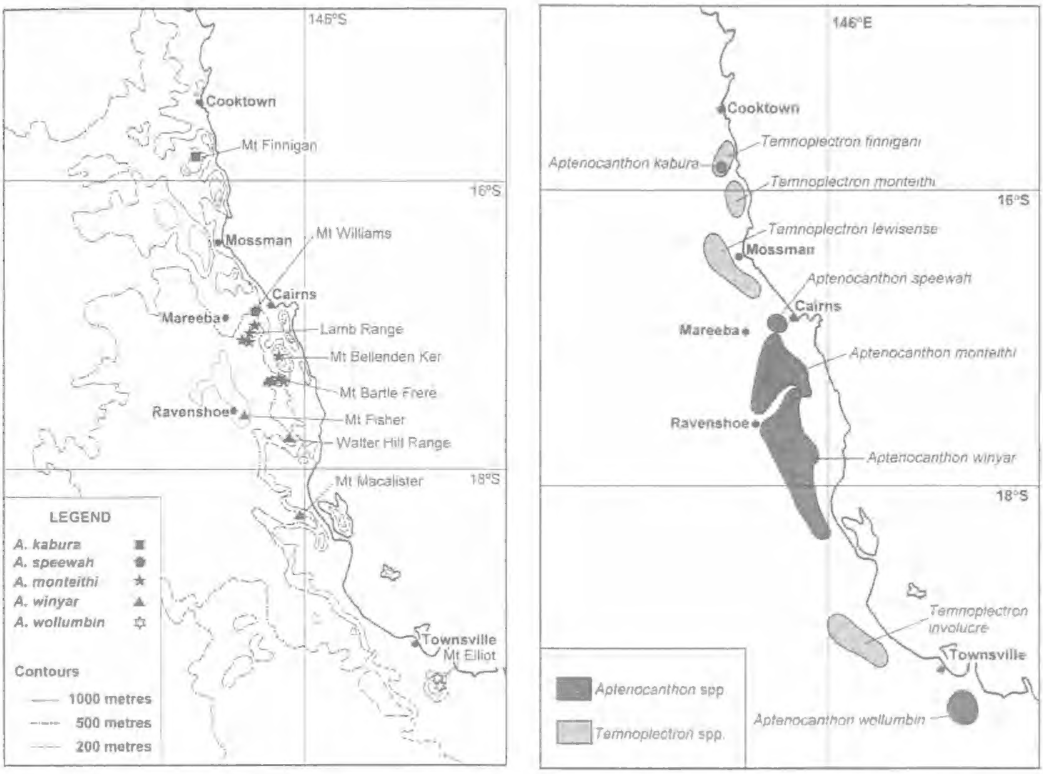

FIG. 8. A, distribution of *Aptenocanthon* spp. in the Wet Tropics region of north Queensland; B, schematic view of distribution of *Aptenocanthon* spp. compared to that of flightless, rainforest species of *Temnoplectron* in the Wet Tropics.

Wet Tropics. Neither occurs on the Tableland itself which, at around 700-800m, is apparently below the altitudinal requirement for the genus.

The absence of *Aptenocanthon* from certain apparently amenable range systems in the Wet Tropics, such as the Paluma Range and the Carbine Tableland, is curious. However comparison with the distribution of ecologically and physically similar flightless species in the genus *Temnoplectron* (Reid & Storey, 2000) indicates that there may be complementarity of distribution of these two taxa operating. There are four species of small, wingless, rainforest *Temnoplectron* in the region: *T involucre* Matthews from the Paluma Range, *T. lewisense* Reid & Storey from the Carbine Tableland, *T. monteithi* Reid & Storey from the Thornton-Sorrow mountains and *T. finnigani* Reid & Storey on Mt Finnigan and nearby peaks. If the distributions of these are mapped in comparison with *Aptenocanthon* species (Fig. 8B) a clear pattern of mutually exclusive occurrence is revealed. There appears to be a niche available for a small, convex, wingless canthonine dung beetle in high altitude rainforests and this has been filled by one or the other genus on different isolated mountain systems during the climatic and vegetational fluctuations which have occurred over time in the region. The only locality where both *Aptenocanthon* and flightless, rainforest *Temnoplectron* occur together is on the summit of Mt Finnigan. There the abundant *T. finnigani* is sympatric with the extremely rare *A. kabura*. All other Wet Tropics *Aptenocanthon* species are very common in their habits, without competition from flightless *Temnoplectron*. The rareness of *A. kabura* on Mt Finnigan may inicate that it is not competing well with *T. finnigani* and indeed may be only surviving at the highest altitude available in that mountain system.

ACKNOWLEDGEMENTS

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